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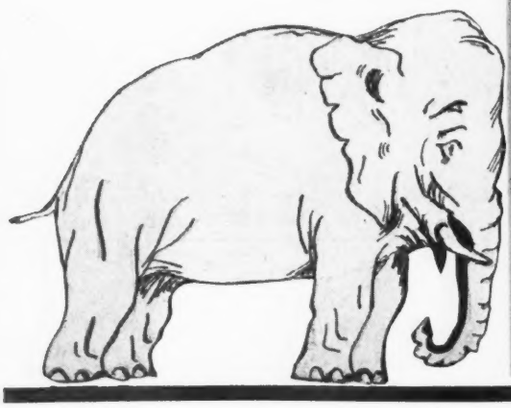

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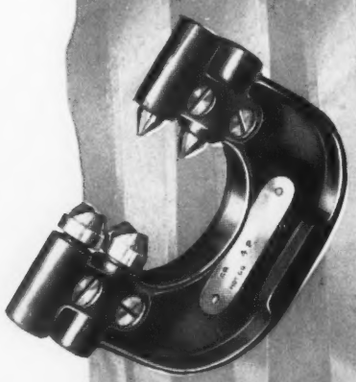

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Pipe and Tube Bending

Different Types of Fixtures and Machines Used for Making Bends Without Distortion

By FRANKLIN D. JONES

IN BENDING a pipe or tube, the outer part of the bend is stretched and the inner section compressed, and as the result of opposite and unequal stresses, the pipe or tube tends to flatten or collapse. To prevent such distortion, the common practice is to support the wall of the pipe or tube in some manner during the bending operation. This support may be in the form of a filling material that is placed inside the pipe, or it may be external only and consist in using a bending device provided with curved or concave forms or rolls that prevent collapse in making the bend.

The equipment used for bending may be merely a simple hand-operated fixture or a power-driven pipe-bending machine, the apparatus used depending upon the size of the work and the amount of bending to be done. Some of the bending fixtures are special and intended for making a certain bend or combination of bends in duplicate pipes, whereas other fixtures are designed for general application. Pipe- and tube-bending machines are also designed in some instances for special work, and in others for general application, although machines of the latter class require more or less special equipment, such as bending forms or rolls of the required radius. After giving some general rules for determining bending allowances and the permissible bending radius for a pipe of given diameter, various classes of pipe- and tube-bending apparatus will be described and illustrated by means of simple diagrams that represent particularly the important features of the bending mechanisms and the principle governing their action.

In determining the required length of a pipe or tube before bending, the lengths of the straight sections are, of course, added to the lengths of the curved sections in order to make the proper allowance for bends. The following rules may be used for finding the lengths of the curved sections.

Rule: To find the length of a 90-degree or right-angle bend, multiply the radius of the bend by 1.57 (the radius is measured to the center of the pipe or to a point midway between the inner and outer walls).

Rule: To find the length of a 180-degree or U bend, multiply the radius of the bend by 3.14.

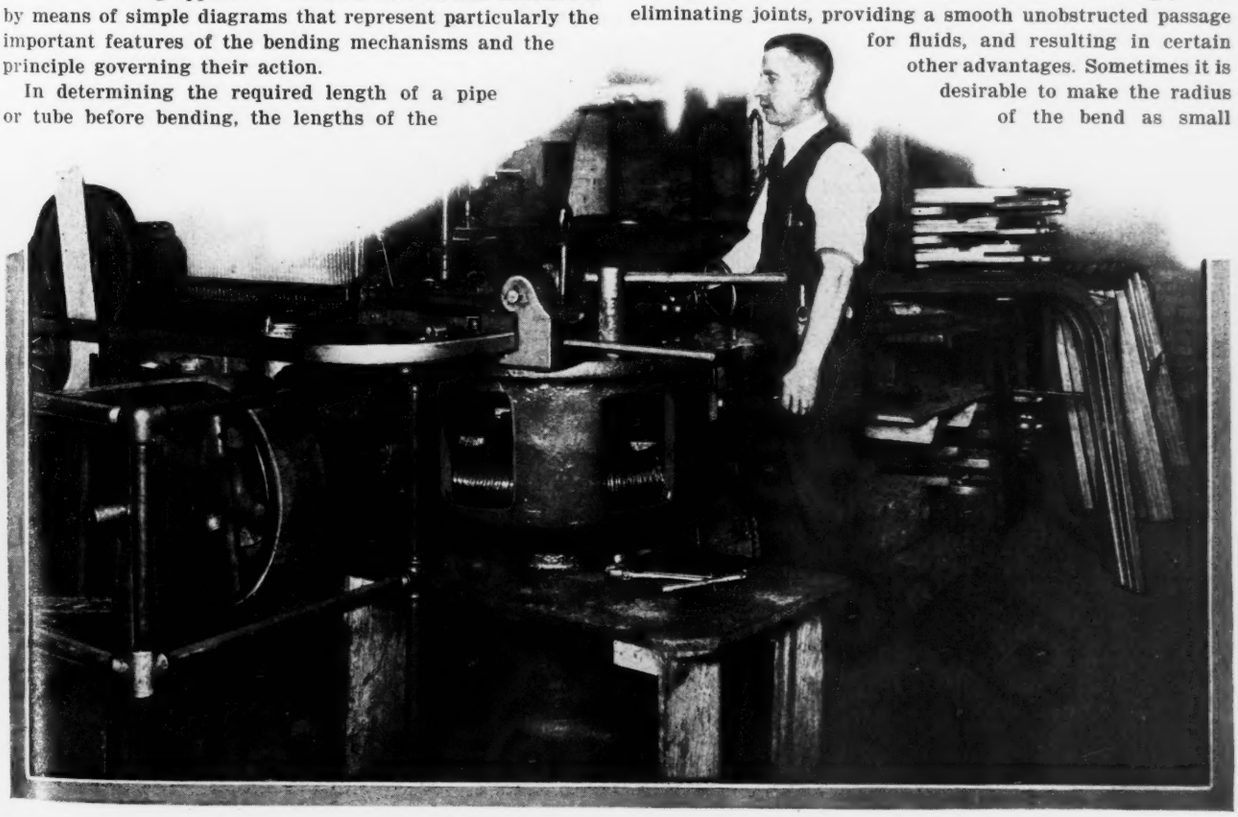
Example—A right-angle or 90-degree bend is to have a radius of 10 inches and straight sections on each side of the bend of 5 and 15 inches, respectively. Find the total length of the pipe before bending.

Length of curved part $= 1.57 \times 10 = 15.7$ inches; hence total length $= 15.7 + 5 + 15 = 35.7$ inches.

A general rule for finding the lengths of sections having degrees of curvature other than 90 and 180 is as follows: Multiply the radius of the bend by the included angle, and then multiply the product by the constant 0.01745. The result is the length of the curved section.

To prevent flattening at the ends there should be a straight section adjoining the bend equal at least to the pipe diameter or to 1 1/2 times the diameter for pipes larger than 10 inches.

Pipes are often bent to avoid the use of fittings, thus eliminating joints, providing a smooth unobstructed passage for fluids, and resulting in certain other advantages. Sometimes it is desirable to make the radius of the bend as small



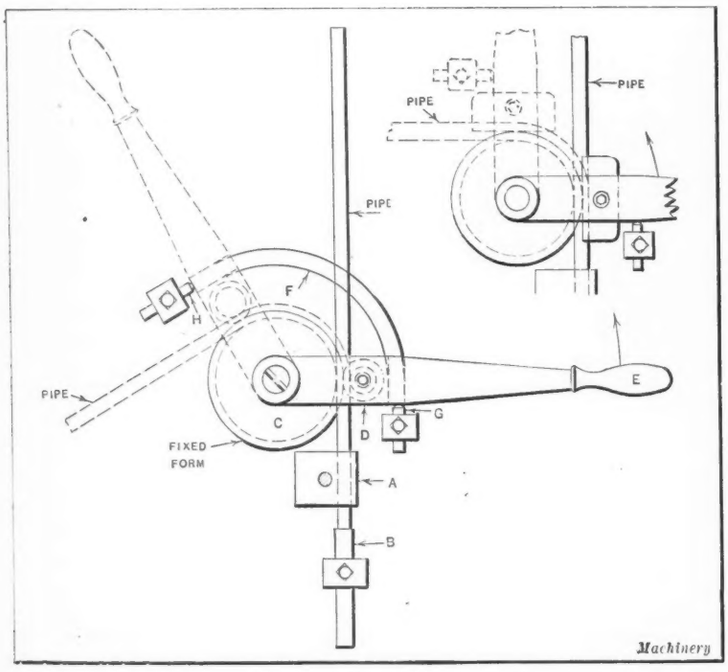


Fig. 1. Pipe-bending Fixture having a Fixed Form and a Rotating Forming Roll; (Detail View) Forming Roll replaced by Straight Forming Block

as possible without causing distortion, whereas on other classes of work, the radius may be comparatively large, as, for example, when pipes are curved to provide means of compensating for expansion and contraction in a line of piping.

The safe minimum radius for a given diameter, material, and method of bending depends upon the thickness of the pipe wall, it being possible, for example, to bend extra heavy pipe to a smaller radius than pipe of standard weight. As a general rule, wrought iron or steel pipe of standard weight may readily be bent to a radius equal to five or six times the nominal pipe diameter. The minimum radius for standard weight pipe should, as a rule, be three and one-half to four times the diameter. It will be understood, however, that the minimum radius may vary considerably, depending upon the type of fixture or machine used for bending. Extra heavy pipe may be bent to radii varying from two and one-half times the diameter for smaller sizes to three and one-half to four times the diameter for larger sizes.

Pipe- and Tube-bending Fixtures

Many small pipes and tubes are bent by using hand-operated fixtures which are so arranged that the force for bending is obtained from a direct-acting hand-lever provided with a bending or forming roll. For pipes or tubes of larger sizes, the common practice is to use either a hand-operated or a power-driven machine equipped with reduction gearing, or possibly a toggle mechanism to multiply the power for the bending operation. These special fixtures and machines ordinarily are used for bending pipes and tubes without heating them. Several hand-operated fixtures will be described first.

A simple type of fixture is shown in Fig. 1. The pipe or tube to be bent is held at one end by clamp *A*, which may have a spring located in a counterbored hole to hold it open when the clamping nut is released. Stop *B* serves to locate the pipe so that the bend will be made at the right place. The pipe is bent around the fixed form *C*, which has the radius of the desired bend and is grooved to fit the pipe. The bending or forming roll *D*, which is pivoted to hand-lever *E*, is also grooved to fit the pipe so that the latter is almost completely enclosed along the center line between *C* and *D*. Hand-lever *E* has a supporting pad or runway *F*, which holds roll *D* in alignment with form *C*. The movements of the hand-lever are limited by stops *G* and *H*.

Instead of using a circular roll for bending the pipe about the fixed form, a straight grooved block may be pivoted to the hand-lever, as indicated by the diagram in the upper right-hand corner of the illustration. This straight bending block comes into contact with a larger surface and is sometimes preferred to the roll.

Mandrel Inside of Tube to Prevent Distortion

For certain classes of pipe and tube bending, some form of internal mandrel is used so that the pipe or tube is supported both externally and internally in order to prevent flattening. Internal mandrels are used particularly in connection with the bending of thin tubing. The mandrel may be in the form of a plain cylindrical bar that fits closely inside the tube, or it may be of special form as described later. A plain mandrel is shown at *A*, Fig. 2, in conjunction with a simple hand-operated fixture. The tube to be bent is pushed over the end of the close-fitting mandrel and against stop *B*, which is set to locate the bend relative to the straight portion. The tube is clamped in place by lever *C*, and it is bent by pulling lever *D* in the direction indicated by the arrow, which causes form *E* to rotate about its bearing. This form is, of course, grooved to suit both the radius of the pipe and the radius of the bend, and the pipe is additionally supported by a backing block *F*, which is also grooved and is so located that there is practically no clearance space when the tube is in place.

The arbor should be lubricated to reduce friction as the pipe is drawn off the mandrel in making the bend. The mandrel should project a certain distance x beyond the center line in order to support the pipe to the best advantage. This distance, as well as the amount of curvature at the end of the mandrel, may be determined by experiment.

Fig. 3 shows a mandrel that has a formed end to fit the curved section of the pipe and provide a larger supporting surface. The fixture otherwise is quite similar to the one just described. There is a stop *B*, a backing block *F*, and a clamp *C*, the same as in the fixture previously described. The detailed view in the upper right-hand corner shows more clearly the shape of the mandrel. This end may be finished to the right curvature by using a forming tool having a radius equal to the inside radius of the pipe. The mandrel is held in a lathe chuck and the tool in the toolpost. The end is then formed by swinging the tool while the work is held stationary, the swinging movement being obtained by loosening the swivel of the tool-slide. It will be understood that the tool must be located at a distance from the axis of the swivel equal to the radius of the desired bend.

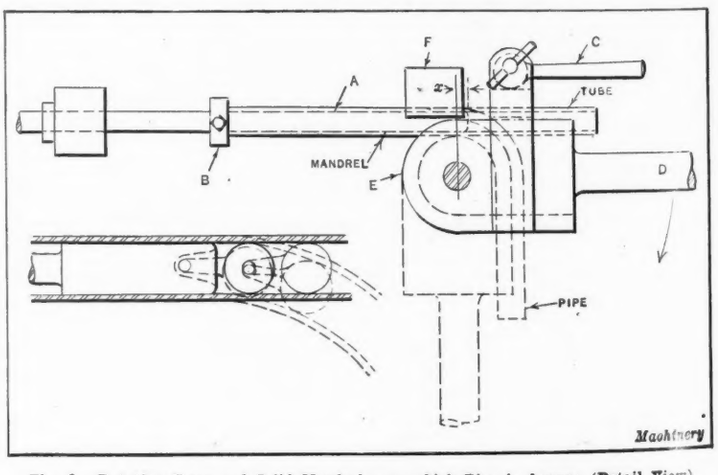


Fig. 2. Rotating Form and Solid Mandrel over which Pipe is drawn; (Detail View) Ball Type of Mandrel used for some Tube-bending Operations

The ball type of mandrel illustrated by the enlarged detail view, Fig. 2, has been used for many tube-bending operations. These balls are so connected that they have a limited amount of movement, and they partially support the curved section of the tube, as indicated by the dotted lines. This general type of mandrel has been used both on hand-operated fixtures and on power-driven pipe- and tube-bending machines.

Tube Bender Equipped with Oval Mandrel

The type of bender illustrated by the diagram Fig. 4 is used for bending 5/8-inch brass tubing of No. 22 gage, and a similar design has been made for bending steel tubing up to 2 inches diameter and No. 16 gage. The tube is bent to a half circle, or to an angle of 180 degrees. The position of the bending arm at the beginning of the operation is indicated by the full lines, and its position at the completion of the operation by the dotted lines. The tube to be bent is held against lengthwise movement by a screw-operated clamp at *E*, and the tube is properly located by placing the end in contact with bracket *F*, which is bolted to and moves with the bending arm. The tube is bent around a fixed form *A* by roll *B*, which is pivoted to block *C*. This block is carried by the bending arm, the leverage of which is increased by inserting a piece of pipe over projection *D*.

While removing a bent tube or inserting a straight one, roll *B*, with sliding block *C*, is withdrawn slightly to provide clearance. After a straight tube has been clamped in place, roll *B* and block *C* are advanced to the bending position by turning eccentric *J*, the shaft of which is provided with a small hand-lever (not shown). Roll *B* and form *A* are, of course, grooved to fit the outside of the tube. Inside the tube there is an oval-shaped mandrel *G* which is held in position by rod *H* connecting with arm *F*. As the bending lever and roll *B* swing to the left, mandrel *G* follows, thus supporting the inner wall of the tube and preventing any flattening or distortion. Roll *B* is slightly in advance of the mandrel, so that it prevents the tube from lagging behind rod *H*. This rod serves to hold mandrel *G* in a fixed position relative to roll *B*, and the mandrel is, in effect, drawn out through the tube in making a bend, as will be apparent by comparing the relative positions at the beginning and completion of the bending movement.

Pipe-bending Machine Having Lever-operated Bending Shoe

The pipe-bending machine represented by the diagram Fig. 5, which is a plan view, has a fixed form *A*, around which the pipe is bent as the result of an intermittent bending action from shoe *B*, which is forced against the pipe by a gear-operated lever. This machine, which is made by the Leonard Machine Works, Lansdowne, Pa., is, of course, intended for bending pipes without heating and without the use of filling material. The inner end of the pipe is held by a strap or clamp *C*, and hand-lever *D*, through pinion *E* and segment gear *F*, causes shoe *B* to bend the pipe around form *A*. After each stroke of hand-lever *D* and shoe *B*, the bending mechanism, which is pivoted at the center of form *A*, is swung around in the direction of the bend, the shoe being forward on the pipe so that the next stroke will be effective. A pawl controlled by handle *H* engages a "circular rack" or gear *G* below the bending mechanism, thus holding the latter in the desired position. This machine may, of course, be applied to hot work, as in bending pipes to an exceptionally small radius.

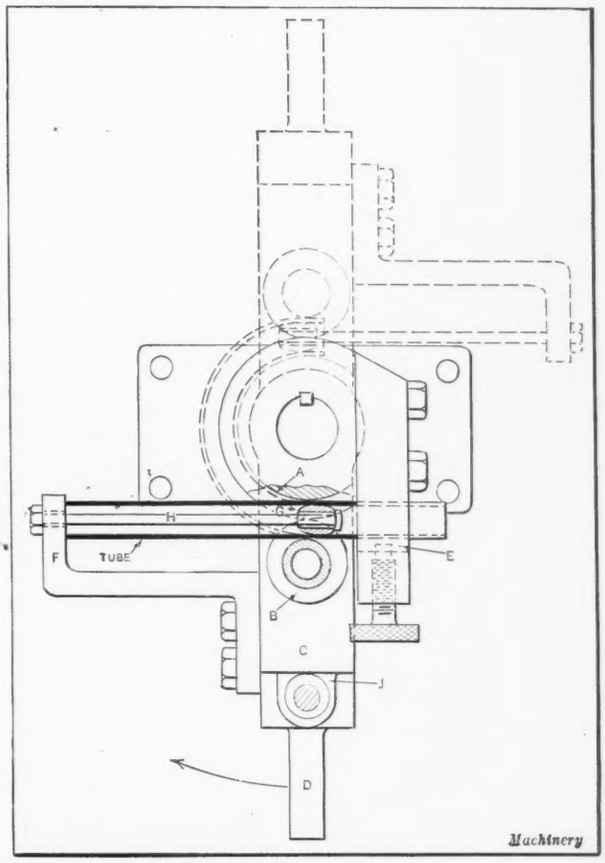


Fig. 4. Tube Bender having Oval Mandrel which moves with Bending Roll

Machine Having Rotating Form and Adjustable Resistance Roller

The diagram Fig. 7 represents a machine having a form *A* bolted to a faceplate attached to gear *B*, which is driven through pinion *C*, gear *D*, and pinion *E*, the latter being turned by the handles shown. One end of the pipe is clamped to form *A*, and the resistance roller *F*, mounted on a swiveling arm, is located at whatever point gives the best results.

The machine represented by the diagram Fig. 8 differs from the one just described chiefly because of the adjustable backing roll *G* with which it is provided. The drive is from the hand-levers through a compound train of gearing, as described in the preceding case, to faceplate gear *B*. On the faceplate there is a driving lug *H* which comes into contact with the end of the pipe. The dotted lines illustrate the action of the machine in making a right-angle bend. This machine has an adjustable stud or roll at *F*, like the one just described, and the backing roll *G* may also be adjusted to suit the work.

Horizontal Type of Machine Having Fixed Form and Rotating Bending Roll

The machine illustrated by the diagrams Figs. 7 and 8 are vertical designs, the form around which the pipe is bent being in a vertical plane. Although these machines have been used extensively, the designs have been superseded by the horizontal type illustrated by the diagram Fig. 9, which represents a plan view. This machine has a

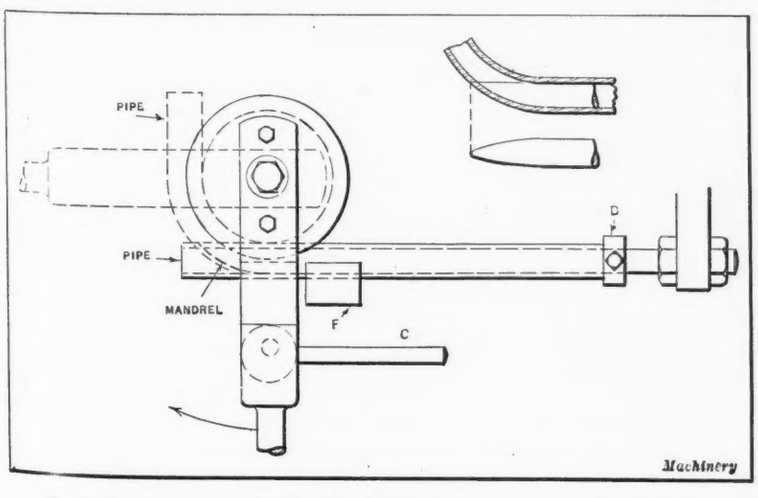


Fig. 3. Rotating Form, and Mandrel having Formed End to increase Supporting Area inside Pipe

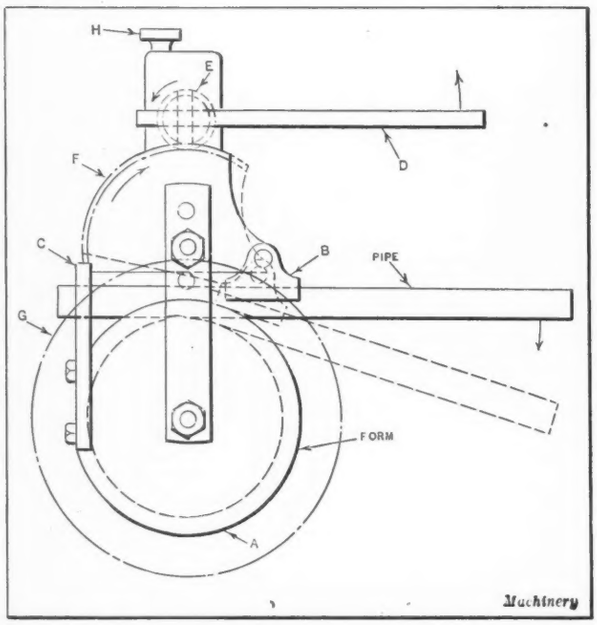


Fig. 5. Pipe-bending Machine equipped with Concave Bending Shoe operated through Segment Gear Mechanism

resistance plate that supports a small saddle *A*. The saddle bears against the pipe and remains stationary while roll *B* bends the pipe around the fixed and grooved central roll *C*. Roll *B*, instead of being grooved, is cylindrical, and acts against a shoe *D* which is grooved to fit the pipe, thus distributing the bending pressure. The bending arm which carries roll *B* is bolted to the faceplate. The faceplate, which revolves within a cavity in the main housing, is driven through faceplate gear *G*, pinion *H*, and bevel gearing *J*, which connects with the operating handles. This type of pipe-bending machine is also equipped with an electric motor drive.

Holes in the rim of the main housing and outside of the faceplate serve to locate the resistance plate to which saddle *A* is attached. A stop *E* is bolted to the faceplate and engages a fixed stud *F* which is inserted in the housing rim. In using this machine, the bending roll *B* must be properly located with reference to the central roll or form *C*. Bends up to 180 degrees may be made with this machine without using special equipment. These machines are manufactured by the Pedrick Tool & Machine Co., 3639 N. Lawrence St., Philadelphia, Pa.

Machine Having Rotating Form and Adjustable Forming or Backing Rollers

The diagram Fig. 11 represents a machine (made by the Baker Ice Machine Co., Inc., Omaha, Neb.) that has a rotating form *A* around which the pipe is bent. The end of the pipe is secured to this form by clamp *B*. As the form rotates, the pipe is drawn past the forming or backing rollers *C* and around the form itself, as indicated by the dotted lines representing the position after making a bend of 180 degrees. These backing rollers are mounted on a slide to provide adjustment by means of a screw and handwheel. This diagram represents a belt-driven machine. In making a bend, clutch *D* engages pulley *E*, which, through spur gearing *F* and worm-gearing *G*, drives form *A*. A stop or dog beneath the table rotates with the form and is set to strike a lever which engages a lug on the clutch rod, thus throwing the clutch to neutral at the completion of the bend. Then after removing the bent pipe, the clutch is shifted to engage the reversing pulley *H*, thus returning form *A* to the starting position. This provision of an automatic stop and power reversal is found on different makes of power-driven pipe-bending machines.

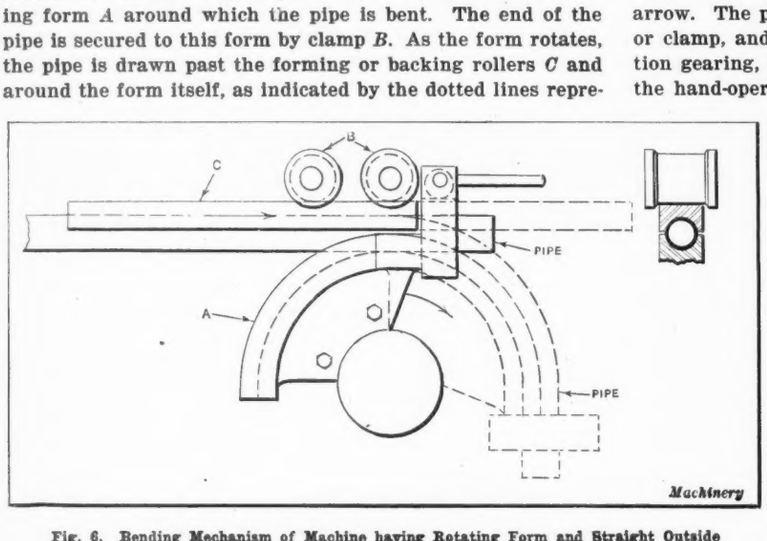


Fig. 6. Bending Mechanism of Machine having Rotating Form and Straight Outside Follower Bar between Pipe and Backing or Pressure Rolls

Machine Equipped with Rotating Form and Straight Follower Bar

The pipe-bending machine illustrated by the diagram Fig. 6 has a rotating form *A*, around which the pipe is bent, and two adjustable backing rolls *B*. It will be noted, however, that these rolls do not bear directly against the pipe, but against a straight follower bar *C*, which is grooved to fit the pipe (see sectional view at right) to increase the supporting area. The dotted lines indicate the action in making a 90-degree bend. It will be seen that as form *A* revolves, follower bar *C* moves in a straight line, as indicated by the arrow. The pipe is secured to the form by means of a strap or clamp, and the drive is through a combination of reduction gearing, the arrangement of which varies somewhat on the hand-operated and power-driven machines.

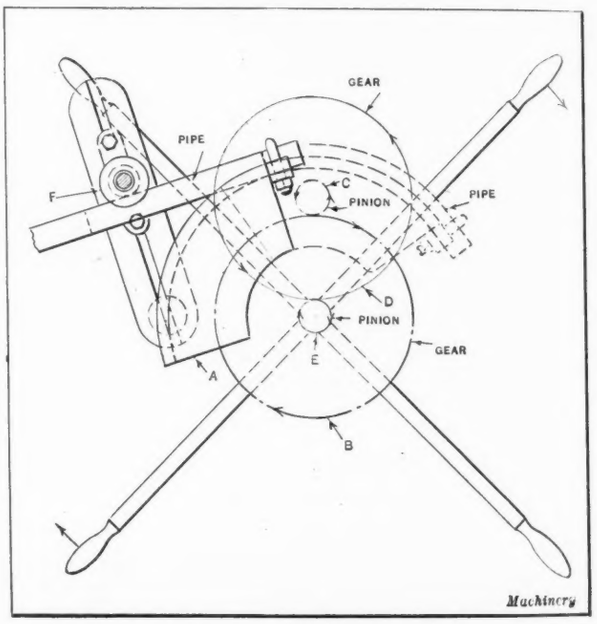


Fig. 7. General Arrangement of Pipe-bending Machine having Rotating Form and Adjustable Resistance Roll

Some machines of this type, used for bending thin tubing to a small radius, are provided with inside mandrels. Tubing having a wall thickness greater than 1/16 inch can be bent by using the straight outside follower bar only, without the internal mandrel. If both the outside follower and mandrel are used, a 1-inch tube with a 1/32-inch wall thickness may be bent to a 6-inch radius; a 1-inch tube, 1/16 inch thick, to a 4-inch radius; a 1 1/2-inch tube, 1/32 inch thick, to a 9-inch radius; a 1 1/2-inch tube, 1/16 inch thick, to a 7 1/2-inch radius; a 2-inch tube, 1/32 inch thick, to a 16-inch radius; and a 2-inch tube, 1/16 inch thick, to a 12-inch radius. Machines of the type just described are manufactured by the Wallace Supplies Mfg. Co., 1310 Diversey Parkway, Chicago, Ill.

Methods of Bending Continuous Coils

One type of machine used for bending spiral or, more properly, helical coils of pipe is illustrated by the left-hand diagram in Fig. 10. This machine has four rolls mounted on blocks provided with screw adjustment. The rolls are grooved to suit the pipe, and the position of the roll at the extreme left governs the radius of the bend. The pipe is pushed forward by a hydraulically operated carriage having a clamp that grips the pipe. The hydraulic cylinder and the carriage are located below the pipe, and after each forward stroke, the clamp is released, the carriage withdrawn to the starting point, and the clamp again tightened preparatory to pushing another section of the pipe between the bending rolls. The last roll is elevated enough to separate the different turns or give the coil the required pitch. If the pipe is heated for bending, a gas furnace is usually located close to the coiling machine, and sometimes different pipe sections are welded together, either electrically or by hand, in bending long coils.

Another type of coiling machine is illustrated by the diagram at the right of Fig. 10. This machine has a circular form *A* around which the pipe is bent, and an adjustable backing block *B* (or roller on some machines). The pipe is clamped to form *A* by clamp *C*, which is represented in the starting position by the dotted lines at *D*. After form *A* turns about one-half revolution, clamp *C* is released and form *A* is turned back to the starting position; the clamp is then tightened, and as form *A* moves forward again another half turn, the coil bending is continued. The upper flange of form *A* is cut away on one side, as indicated at *B*, to provide clearance for the pipe as it is turned upward to form coils of the required pitch. The drive to form *A* is through worm-gearing and a clutch mechanism (not shown), which provides the necessary reversal of motion.

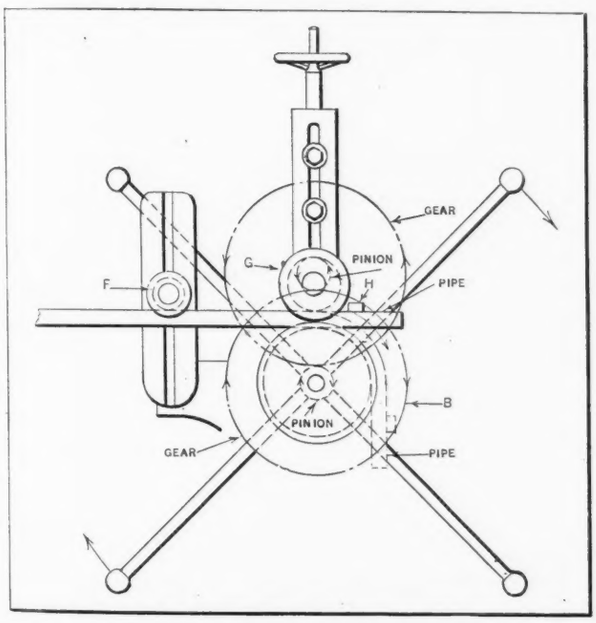


Fig. 8. Pipe-bending Machine provided with Adjustable Backing Roll in Addition to an Adjustable Resistance Roll

Use of Filling Material to Prevent Flattening at Bend

A simple method of preventing distortion and one that has been widely utilized, especially when pipe or tube bending is done by hand and on a small scale, consists in using some filling material which is placed inside the pipe to support the walls to prevent flattening at the bend. Dry sand is often used for this purpose. The sand should be rammed tightly into the pipe to fill it completely, and then the ends should be capped so that all the sand will be retained. The section to be bent is next heated, care being taken to avoid overheating. Before bending, the outer surface is cooled by using water, so that the inner wall will be compressed; this causes the cubic contents of the pipe to be reduced slightly by the bending, whereas, if the outer portion were not cooled and were permitted to stretch, the space within the pipe would be increased somewhat. The cooling method, therefore, enables the filling material to provide a firmer support.

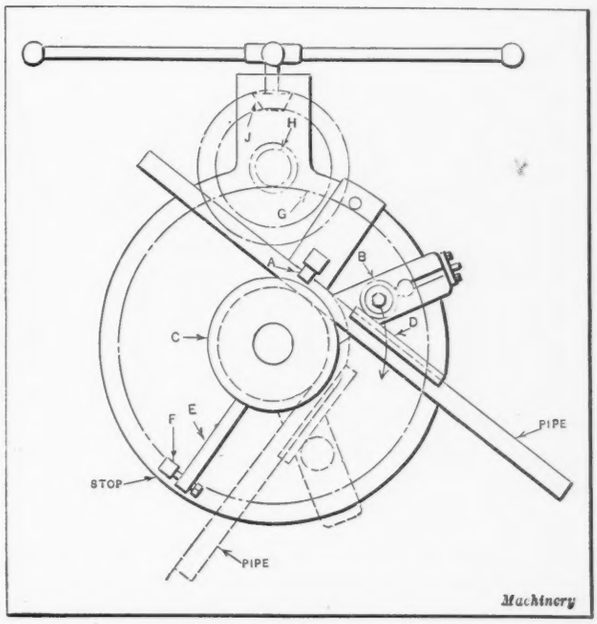


Fig. 9. Diagram of Horizontal Type of Pipe-bending Machine having Fixed Form and Rotating Bending Roll

Other filling materials, such as rosin or lead, are sometimes employed. The pipe is first filled either with molten rosin, lead, or some alloy having a low melting point, and then after bending, the pipe is heated sufficiently to melt the filling material. Rosin has often been used for bending small brass and copper pipes, and lead or some alloy for small iron and steel pipes. Before bending either copper or brass pipe or tubing, the latter should be annealed.

A snugly fitting coil spring has been used instead of one of the filling materials mentioned. One method of removing the spring after bending is to fasten one end of the spring to a lathe spindle, which is then rotated so as to wind the spring in whatever direction will reduce its diameter. The spring should be lubricated before using.

Location of Seam in Butt-welded Pipe

Whenever a pipe or tube is bent, the outer fibers of the curved section are stretched and the inner fibers are compressed, and between these sections that are subjected to tension and compression there is a neutral axis located about midway between the inner and outer curves. Therefore, it is

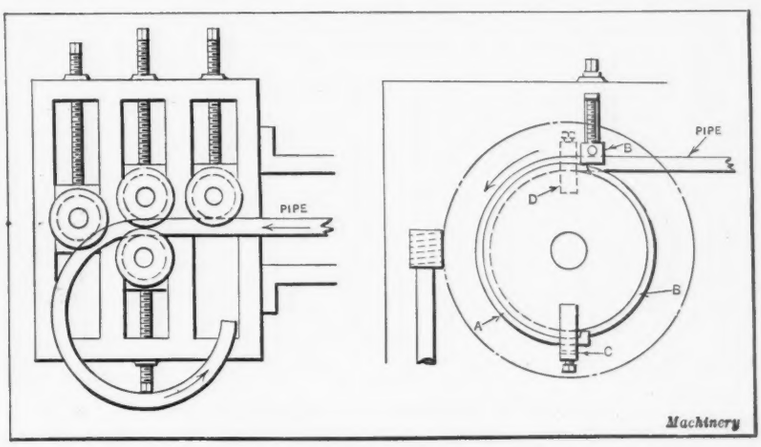


Fig. 10. Two Methods of forming Continuous Coils of Pipe

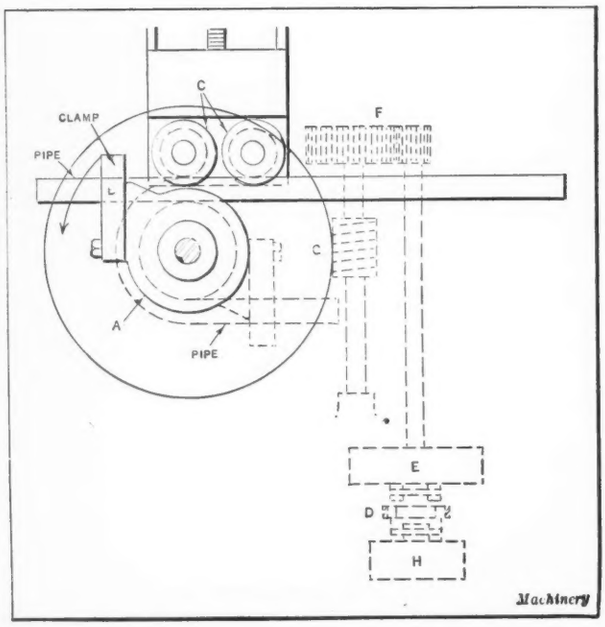


Fig. 11. Diagram of Power-driven Machine having Rotating Form and Double Backing Rolls in Contact with Pipe

generally considered good practice to locate the seam in butt-welded pipe along this neutral axis or section, in order to lessen the danger of rupture or cracking. However, if the bend is made by heating the pipe and then cooling the outer part of the curve, so that the bending is the result principally of compression, the seam, according to at least one experienced manufacturer, should be along the outer curve.

* * *

TRADE INSTRUCTION IN GERMANY

Although the German Association for Technical Instruction dates back to 1908, it is only during the past year and a half that the general activities of this association have been known internationally through a paper read by Dr. Zur Nedden before the World Power Conference in July, 1924. The association, the name of which is generally abbreviated "Datsch" was founded by the Verein Deutscher Ingenieure and the Verein Deutscher Maschinenbauanstalten; but the scheme soon attracted adherents outside the purely engineering professions, and is now supported by forty-five technical bodies of all classes and interests. The Datsch itself has become the central office for what may be called intermediate technical instruction, the training of apprentices and employes coming from ordinary or trade schools and intending possibly to proceed in due time to technical colleges, chiefly while they are working in factories and shops, and at the same time studying at home.

The scheme has the support of the leading manufacturers, who arrange for suitable evening courses, free of charge, at which are utilized the special charts, wall maps, slides, tables, and booklets supplied by the Datsch. The diagrams and explanations in the pamphlets provided give very clear instructions to the worker how to do a thing and how not to do it, covering work in the drawing office, the machine shop, foundry, pattern shop, testing room, etc. The booklets are fitted into strong cardboard and cloth folders, 8 1/2 inches by 6 inches. The folder provided grips the booklets, but keeps them open wherever desired.

These booklets cover, or are to cover, all trades. The drawings reproduced are made in accordance with the principles laid down by the NDI, the Normenausschuss der Deutschen Industry (German Standards Association) whose publications are known as DIN books (German Industry Normals). The rules of the Datsch are drawn up in consultation with the manufacturers, educational authorities, and with due regard to international practice. Detailed nomenclatures in different languages are in preparation. One of the first pamphlets issued dealt with the script to be used on engineering drawings. What is termed "Blockschrift" is all oblique lettering; the proportionate sizes of small and capital letters and of figures are fixed. Thus, for instance, with a line spacing in the text of 10 millimeters, the capitals should be 7 millimeters high and the small letters 5 millimeters; the thickness of the letter strokes is always to be one-tenth of the line spacing.

The pamphlets mentioned and the large- and small-scale maps and drawings are obtainable from the Beuth-Verlag, Berlin, S.W.19, Beuthstr. 8.

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HIGH PRODUCTION IN DRILLING CONNECTING-RODS

In drilling the bolt holes in the crankpin end of connecting-rods at the Ajax Motors Co., Racine, Wis., use is made of the multiple-spindle machine shown in the accompanying illustration. The operation is performed before splitting off the cap of the rods. Sixteen spindles are arranged above a rotary fixture on which twelve rods can be supported at one time. There are no spindles above that portion of the fixture that happens to be at the front of the machine at any time; this arrangement enables four connecting-rods to be reloaded while the operation is in process on eight others. Drills in eight of the spindles produce the holes in four connecting-rods to about one-half the depth, and the other eight drills complete the operation on the same rods when they have been indexed into the proper position. Thus four rods are completed at each 120-degree indexing of the machine.

The machine is entirely automatic except for reloading, and is of the cam feed type. There is a quick approach of the drills to the point where the drilling commences, then a slowing down of the feed for the operation, and finally a rapid return of the drills to the upper position to permit indexing the fixture. The rods are mounted vertically by means of plugs on which the two bearings are seated, and they are held in place by clamps, each of which forces the crankpin end of two rods against the fixture. Each clamp is conveniently tightened and loosened by applying a wrench to a nut. A production of 1200 connecting-rods is obtained on this machine per ten-hour day. The machine was built by the Moline Tool Co., Moline, Ill.

Multiple-spindle Machine used in drilling 1200 Connecting-rods per Day

The Management of Men in Industry

By J. SETON GRAY, Industrial Engineer, A. O. Smith Corporation, Milwaukee, Wis.

UNDER ordinary circumstances, work is more or less plentiful in the United States, so that a man can pick his job to suit himself. A great many men feel—especially the younger generation—that it does not pay to stay too long in one place, because if they move around, they will both learn and see more and quite frequently be able to increase their remuneration.

The wise employer realizes that changing men is often a costly proposition, and he takes all the steps he can to control this. When a man can leave one place today and get another place tomorrow, it is essential for the employer to attract worthwhile employes to his factory and, by making their surroundings congenial, induce them to stay. A man will do more and better work in a place where he feels happy and contented, and where he feels that someone is interested in seeing him started right, than he will in a factory where he is left to his own resources from the beginning.

Starting a New Man Right

First impressions are lasting, and if a man feels that efforts are being made to start him in right, he will have more friendly feelings toward the management than he would if no attention were paid to him. A new man should be instructed regarding factory rules and regulations, and the particular machinery and equipment with which he must perform his work.

A man appreciates a place of his own. We all love our own home, and in a factory a man appreciates having some corner that is his. It encourages a man, when he starts work, to find that there is a clean place provided where he can leave his good clothes and be sure to find them on his return. He feels that when lockers are provided where his lunch can be kept, and a place where his coffee is heated for him, that an effort is being made to look after his welfare.

Same Rules Should Apply to all Departments

Some foremen are much more strict than others. I have in mind a very efficient foreman who insists that all his men be at their places ready when the whistle blows to start work. He makes a practice of reprimanding every man who is not there at that time. The foreman in the department next to this one is rather easy-going; men drop in at all times after the whistle has blown, and nothing is said. The average man admits that he should be on the job when the whistle blows, but what he does, he wants everybody else to do. If everybody is treated alike, he is satisfied, and it is a superintendent's job to see that all foremen comply with the factory regulations and interpret them in the same manner; otherwise there will be a number of men who feel that they are being discriminated against, and who will look elsewhere for a place where everybody is treated alike.

Relieving the Monotony of Repetition Work

The tendency in modern manufacturing is toward specialization. A man is kept on one job so that he may become an expert. He may make an effort to be transferred to a new class of work, so as to widen his experience, but he invariably finds it difficult to be transferred, as he is more valuable to his foreman on the class of work he is engaged on. Consequently, he finds that the only way to get a change of work is to quit. The same job day after day becomes very monotonous, and the wise foreman, recognizing this, moves his men around so that they get a chance at something new. The average man prefers this, even when it means reduced earnings until he has become proficient; and there is the added advantage to the foreman of having a gang that is more flexible, so that he can take men from different jobs to concentrate on something that may be in demand. Handling a gang along these lines pleases the men, and gets results for the foreman.

Keeping the Man Interested in His Job

Some employers feel that there must be an air of mystery in all their dealings with the men. The man on the job has no idea what he is doing, or why; all he knows is that certain work must be performed. A workman is human, and likes to know the "why" of his job, and the reason why work is being done in a certain way. It may take a little time to explain, but when a man knows what he is doing, and why, he will feel more satisfied and work to much better advantage. Men like to feel that their efforts are constructive and that they are doing something worth while. Don't let a man work in ignorance, as he wants to feel the joy of accomplishment just the same as the employer.

In many large plants the man on the job has no idea of the object of the work he is doing. All he knows is that certain work must be performed. A workman is human and likes to know the "why" of his job, and the reason why work is being done in a certain way. It may take a little time to explain, but when a man knows what he is doing and why, he will feel more satisfied and work to better advantage. Men like to feel that their efforts are constructive and that they are doing something worth while. Do not let a man work in ignorance, because he wants to feel the joy of accomplishment just the same as the employer.

Maintaining Pride in the Work

Men take pride in their job, even though the job may be the digging of ditches. You will find men digging ditches who take pride in seeing the side walls perfectly straight and the ditches follow the lines laid out by the foreman. Never do anything either by word or deed that will take the pride in his job away from the workman. A motor tender who is responsible for the care and upkeep of a hundred motors takes pride in seeing all these motors performing work when required. If anyone does anything that to his mind jeopardizes the running of a single motor, he will fight to the last ditch. He has pride in his job, and the successful superintendent cultivates and develops this trait in all his men.

When a man has merited consideration do not hesitate, but give it to him. A man will feel better pleased and more satisfied with a raise of pay amounting to two cents per hour that has come to him voluntarily than he would with a five-cent an hour increase that he had to solicit.

Plan Carefully before Going Ahead

How often you see a foreman change his mind three or four times, for no apparent reason, after a start has been made on a job. The men will stand for it the second time, but after that their interest is gone, as they think: "What's the use? After we work on this for a little while it will be changed again anyway, so let's take it easy."

Lack of proper planning on the part of the foreman means that the men cannot plan their own work properly, and there is bound to be confusion and inefficiency. Men like to look up to their leader, and when this leader can command their confidence, and deserve it, you will find an efficient gang.

The bluffer has no place in any organization, and men will put themselves out to call his bluff; they will even do work wrong purposely just to show that he doesn't know what he is talking about. They respect the fellow who says, "I don't know, but I think this is the proper way to handle the job." A workman realizes that a foreman cannot know everything, but he likes to hear him admit it, rather than bluff it through.

When a Promise is Made it Must be Kept

A man likes to feel he can depend on a promise given him by a superintendent or a foreman. How often do you find men with their tools all wrapped up ready to quit simply because they had been promised something that has later been forgotten. This may have been a change of work or a raise in pay, or something relating to working conditions, but the promise was overlooked. Whenever a promise is made to a workman it should be kept, even if it causes a great deal of inconvenience. It establishes confidence, and no employer of labor can hope to be successful when there is a lack of confidence on the part of the men.

Where piece-work rates are in effect, or group operations in which the gang is paid the average earnings of the whole group, the foremen should be very careful that the rates are understood by all the men who will participate. It seems that the average man has the feeling that the company is trying to get the best of him, and when there is misunderstanding regarding the piece or group rate, it is certain that there will be trouble. This is equally true regarding remuneration for over-time work. When a man works long hours to accommodate the company, it is the foreman's duty to see that he gets all that justly belongs to him. A man does not like to find a shortage in his pay envelope; mistakes are made from time to time, and whenever a claim is made, it should be investigated promptly and, if it is found that the worker is correct in his claim, an immediate adjustment should be made. In any case, whether right or wrong, a clear explanation should be given the man so that he may fully understand the conditions.

Authority Must be Properly Delegated

Some factory managers feel that they are not performing their duty unless they impress the men from time to time by giving instructions when the foreman is not around. They will tell the men that they are not doing the work in the proper manner and should do it some other way. Men like to feel that they are working for some one individual, and that they should not take instructions from anybody else. They lose respect for a factory manager who "butts in," instead of issuing instructions through the foreman. If this happens too often, a man will quit, as he objects to being ordered around by everybody. A workman likes to feel that he is tied up with a real organization, and he feels a loss of self-respect when he must take orders from everybody.

Leaders and Drivers

Men will perform wonders for a leader, but the day of the driver is over, and men today will not work for anyone who has such a reputation. A good leader is a few jumps ahead of the gang all the time. He will have all his men placed, and at work, with the starting whistle. The driver, on the other hand, generally does not know what he is going to do until he faces the problem; the men stand around waiting to see just what is going to happen next, and get more disgruntled right along, feeling that they are getting nowhere.

Objectionable Language is not Necessary to Maintain Discipline

In the average factory, there is a great deal of swearing and foul language used. Language of this kind is unnecessary and merely shows lack of dignity and leadership. A man does not like a mollycoddle, but he respects the man who talks to him as if he were a fellow worker and not a slave, and uses decent language while so doing. Whenever and wherever you hear a lot of foul language in a factory, you can also look for a lot of inefficiency. A good English "damn" never hurt anybody, but some of the other pet phrases one hears around a factory should be left unsaid.

Provide Opportunity for Promotion

The average worker hopes that some day he will graduate from the ranks of the workers and become a gang boss or foreman. The wise employer recognizes this, and whenever there is an opportunity for promotion, he is careful to find out whether the place can be filled with someone from his own organization. There are usually as good men in the plant as you can find outside, and they have the advantage of knowing the factory, the organization, and the product.

A workman likes to feel that merit will be rewarded and that when promotion is in sight someone inside the organization will at least be given an opportunity. Where it is the practice to go outside for all help required, the organization will always be in a state of flux—never permanent. The man in the gang is ambitious, just the same as the president or any member of the board of directors. He is hoping for better things, and when he sees opportunities that he feels should have been his go to an outsider, he is likely to become discouraged and look for an opportunity elsewhere.

Men will perform wonders for a leader, but the day of the driver is over, and today men will not work for anyone with that reputation. A good leader is, first of all, a good planner, who has the work of his men well in hand. The driver, on the other hand, generally does not know what he is going to do until he faces the problem; and then he must act hurriedly without careful thought. The men stand around waiting to see what is going to happen next and have a feeling that they are getting nowhere on the job. The leader has the confidence of his men, and they know that his instructions are based upon knowledge and foresight.

Be sure that there is a logical reason for going outside for assistance, before you go, and let the organization know the peculiar qualifications you are looking for in this particular man which you think none of your present employes possess. If your men do not possess these qualifications, they can be cultivated, and if the men know where they are weak, they can cultivate these qualifications and be ready the next time.

Old employes resent as an intrusion new men being placed over them, especially if they feel that they themselves have the ability to handle the work successfully. A new man who has been placed in charge of old-timers has a hard row to hoe, and it indicates a great deal of ability and tact if he succeeds in winning their confidence.

The Importance of the Type of Leadership and Surroundings

The average workman will reflect the attitude of the organization he is working with and the conditions surrounding him. If the place is dirty and disorderly, and the equipment is not taken care of, the work from such an organization will be of like character. On the other hand, men will respect a clean-living, straight-thinking leader, and will do everything to merit the approval of such a man. The man who has the reputation of being a "square dealer" will go a long way toward being successful with any organization. If he has the respect of his gang because of fair dealing, the gang will be with him; and workmen would much rather be with the boss than against him.

Men like to feel that they are as good as anybody else, and that in many cases it is only force of circumstances that has kept them where they are. They like to feel that opportunity is still among them, and that some day their real chance and opportunity will come.

The politician, or the man who sticks his nose into everybody's business and then carries this knowledge to the boss, thinking to persuade him how well he is looking after his interests, has no place in any organization, and a wise employer discourages such action on the part of any man. Men of this type invariably think they are quite clever, and are

getting away with something that nobody knows of. Invariably the rank and file know better than he does what is going on, and they take real delight in letting this type of man in on secrets that are meaningless, just for the satisfaction of double-crossing him. The man on the job has no use for the "politician," and does everything he can to discredit him.

Proper Respect for a Man's Rights is the Key to Success in Handling Men

Men like to feel that they have the confidence of their superior and that they can be depended upon. If you trust a man, feeling that by so doing he will play fair, his natural instinct is to respond in like manner.

Regardless of what a man is working at, he wants to retain his self-respect, and this he can only do if he is being treated fairly. If anything is done that in any way decreases the respect that a man has for himself, it will invariably show up in his work. Although an employer has bought and paid for his labor, he has not bought a man body and soul. If for any reason a "call-down" is due a man, it should be given to him alone, so that nobody else will hear. The reverse of this is also worth considering: If a man does a good job, or performs a rush job in quick time, it does not do any harm to let him know it.

A bargain is not complete unless it is fair to both sides. The employe feels he has his labor to sell, and desires to market it where he will get the greatest returns. In all business there is always a factor put down as good will; so the employe will sell his labor cheaper where good will goes along with it. A man wants to feel that he is trusted to carry out his side of the bargain without a watch being kept on all his actions. The fair-minded employe does not resent having his efforts measured, provided the employer uses this information in a fair manner; because measurement of effort is the proper gage of wage payment.

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POINTS ON JIG AND TOOL DESIGN

By JAMES McINTOSH

No text-book can be expected to give more than a suggestion as to how a jig for any particular part should be made. Probably no other field permits of such wide variations in design as jig and fixture construction, and yet there are certain fundamental principles that should be followed in designing all fixtures. Before any complicated part can be considered from the machining standpoint, it must be carefully studied and its functions definitely understood, so that the sequence of machining operations may be arranged to give the best results. Generally, the first operation should be that of machining the base or surface by which the part is secured to the machine or to its foundation. This means that the piece must first be leveled by using the widest points of support, and clamped at not more than three points in order to avoid distortion or straining.

Floating clamps to steady the piece, eliminate vibration, and resist the cutting pressure, as well as spring-actuated self-locating stops that can be securely locked in place, should all be so designed and applied that they will not affect the original location of the work, as determined by the three primary locating and clamping points. The order or sequence in which the machine operations are performed is of great importance, and should be decided upon by an experienced designer. Of equal importance is the selection of the locating or registration points.

Procedure in Designing a Jig or Fixture

The first essential step in designing a jig or fixture is to make an accurate outline drawing of the work. This drawing should be made to a scale that can be used for the drawings of every fixture or jig that will be employed for subsequent operations. Every stop and registration point should be indicated on the original lay-out. The amount of material to be added for finishing should never be left to the decision of the patternmaker, but should be indicated on the original drawing by someone who thoroughly understands the machining operations required. The indicating of the amount of finish on the casting drawing also assists in determining if proper clearances are provided. The actual size of the finished piece and the outline of the material added for finish should be clearly indicated on the lay-out drawing.

The usual policy of waiting until a casting is produced before obtaining production cost estimates or contracts is a mistake, as those concerned with the actual production work can, in many cases, suggest changes in the original design which will enable them to handle the work to much better advantage on their own particular equipment. Often the molder or machine shop foreman can suggest slight changes that will greatly reduce the production costs. Perhaps the best procedure is to make a drawing of the work and outline a sequence of operations that may be carefully studied before the pattern is ordered.

Making the Drawings

In designing a jig or fixture, the writer's preference is to make a drawing of the work on vellum paper. This drawing, on which nothing is indicated but full lines as seen from the top, end, or side, is then turned over, and the view of the opposite side drawn in full lines after reproducing the center lines on both sides of the sheet. With such an outline placed under a sheet of vellum, it is an easy matter to duplicate any part of the drawing required in locating stops, clamps and clearance spaces on jigs and fixtures. The advantages of using a transparent sheet on which the outline on both sides can be seen and traced on other sheets are obvious.

The original drawing, once made, is useful in checking all other drawings. Only the points actually used for any given operation need be traced on the detail or operation sheet for that particular operation. In using a sheet on which only full lines are indicated, the outline on the uppermost side always stands out clearly, and the full-line view on the opposite side of the part, drawn on the under side of the sheet, while being visible, is so much fainter that no confusion of the two views is likely to occur. Such a drawing is also valuable in checking an assembly view, as the amount of clearance at every point can be noted.

The assembly drawings of the more complicated jigs and fixtures can be made as soon as the engine details are approved. The fixture details of the more elaborate castings can then be made and sent to the pattern shop. The jig and fixture castings can be sent to the tool-room before the permanent metal pattern is made, in case the latter type of pattern is to be used on production work. This procedure makes it possible to have all the tools and equipment ready for machining the first piece on a production basis as soon as the first regular castings arrive at the shop.

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The strides made during 1925 in the design and construction of generating equipment kept pace with the demands of the rapidly extending central station field. In its annual report of engineering achievements, the Westinghouse Electric & Mfg. Co., calls attention to the work now under way in the construction of an 80,000 K.W. cross-compounding generating unit, stated to be the largest that has ever been built. Each generator is rated at 40,000 K.W., 1800 R.P.M., and the set will be operated in all respects as a single machine. Work is also progressing on the design of a 62,500 K. V. A., 1800 R.P.M. generator, which is the largest single unit machine at this speed that has ever been undertaken by the company mentioned.

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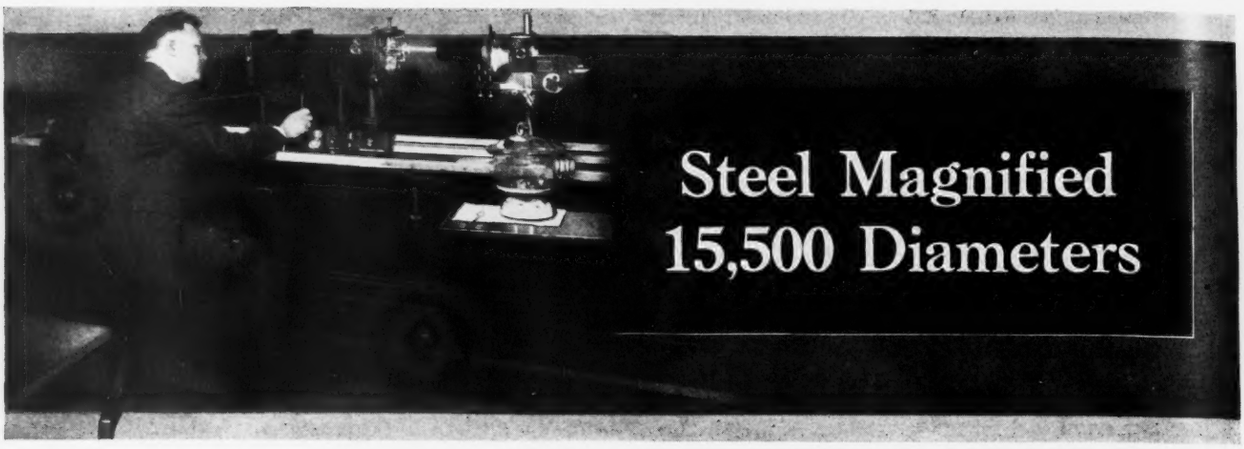
The imports of American automobiles into Germany have increased considerably during the past year. In 1924, only 443 passenger cars were imported, as against 2214 in 1925. One hundred and six trucks and tractors were imported in 1924 as against 718 in 1925. The German automobile industry has been rather hard hit by the present and prospective imports of American cars.



Steel Magnified 15,500 Diameters

How Photomicrographs are Made and Examples Illustrating Their Practical Application

By FRITZ BLOCKI

PHOTOMICROGRAPHY, or the science of photography under high-power microscopes, has been highly developed by R. G. Guthrie of Chicago, as indicated by the fact that he has successfully enlarged and photographed the structure of a piece of steel 15,500 diameters in a single projection. Such magnification is so tremendous that only objects invisible to the naked eye can be dealt with in order to be able to get the enlarged image on a photographic plate. The significance of this enlargement is emphasized by the fact that if the head of an ordinary pin about 3/32 inch across, were magnified to this extent it would become 116 feet in diameter. If the face of a coin, say, a quarter, about 1 inch in diameter, were increased 15,500 diameters, it would stretch out nearly one-quarter of a mile. This combination of lenses, which may be said to form the sharpest eyes in the world, is capable of separating and photographing lines lying so close together that 200,000 of them are contained within a single inch.

In obtaining this remarkable magnification of practically invisible quantities, a vibration of as much as 1/250,000 inch would have made results impossible. One important difficulty lies in focussing the almost infinitesimal extremes in measurement that the work entails. The laboratory in which this work was done is located on the seventeenth floor of a building which covers nearly an entire block. This work necessitates such extreme accuracy that it can only be done at night when there is little traffic passing on the streets over two hundred feet below, for even the passing of a truck on an adjoining thoroughfare is sufficient to jar the photomicrograph or metallograph out of alignment.

The apparatus used in carrying out this work, a Leitz micro-metallograph, consists essentially of a very high power microscope arranged between a powerful automatic arc light and an extremely fine camera, the entire apparatus being mounted on a carriage suspended on sensitive springs so that even a slight movement of the floor will not disturb it. (See the heading illustration). The outfit is about 7 feet long, the camera bellows having an extension of 3 1/2 feet. One of the adjustments on the metallograph is a dial reading to 0.025 inch, arranged so that it can be read up to 0.050 inch. A movement of as much as one of these units is sufficient to spoil the photography at high magnifications. When it is remembered that exposures with a high-power arc light take from thirty minutes to one and a half hours in order to make a picture of a sample, and that even the slight vibration of a twenty-story skyscraper is sufficient to spoil a picture, the difficulty of this work will be appreciated.

The sample to be examined is very small. It need be no more than a tiny fragment, though a piece about an inch in size is preferable for convenience in handling. This is placed on a small platform above the microscope over a tiny hole illuminated by a strong arc light. The image of this exposed spot then passes through the lenses of the microscope and camera where it is finally photographed. Before this is possible, however, elaborate preparation of the sample is necessary in which cleanliness and accuracy are vital.

The preparation of the sample consists of a series of polishing operations which ultimately leave the metal highly polished. This is done on fine disks revolving at 1200 revolutions per minute and covered with very fine soap and powder solutions. The finishing polish is then imparted by a disk covered with silk broadcloth, silk velour, or white flannel, moistened with milk of magnesia which is an excellent finishing compound. The sample is then touched only with tongs so as not to mar the high polish with the fingers.

After being washed in pure grain alcohol, it is dipped in a nitric acid solution which etches or eats away the face of the finely polished surface and exposes the infinitesimal edges of the layers that compose the piece of steel. These are known as lamellae, and run from 15,000 to 80,000 per lineal inch. Magnifying and photographing their arrangement then enables an expert metallurgist to interpret practically the entire life history of that piece of metal, the temperatures and processes through which it has passed, whether it is of high or low carbon content, and various other facts connected with its manufacture.

The photomicrograph Fig. 1 shows at a magnification of 15,500 diameters, the junction of two grains in a sample of steel. They are separated by a boundary of ferrite running between them. The alternate white and black lines were 1/50,000 inch apart in the steel sample from which they were magnified and photographed.

To illustrate the practical application of photomicrography, a manufacturer of steel ball bearings experienced difficulty due to the formation of infinitesimal soft spots in the finished product. The method of cooling was thought to be the cause of the trouble, but no remedy was known. These spots were photographed at a magnification of several thousand diameters. As the result of studies and experiments that followed, two bathroom sprays were so arranged that their streams of water would intersect, and through this intersection was passed a chute on which the heated ball bearings fell through the water. This method of cooling proved to be correct and production was automatically increased 200 per cent.

In the manufacture of steel tank railroad cars, it was discovered that some of the cars would not pass inspection because the rivet heads were pockmarked, denoting imperfections. An effort was made to trace the trouble but it was unavailing. Finally two or three rivets were cut out of an uncompleted car. One of the rivets was then split lengthwise, highly polished, etched, and put under the arc light of the metallograph.

After several hours examination, one of the dies of the riveting hammers was examined; then the mystery was com-

pletely solved. Microscopic photographs showed that the metal around the pits was the same as the rest of the rivets so that there was no flaw in the material. It was thought that they were perhaps being pitted in the gas-fired rivet heaters, but other types pitted them even more. Then examination of the dies showed that these contained soft centers so that they elongated at the bottom under continual pounding, causing them to grip the rivets too high on their heads and giving the effect of turning them inside out, which, in turn, produced the pits. Further investigation brought out the fact that there had been an accidental mixture of steels used in making the dies.

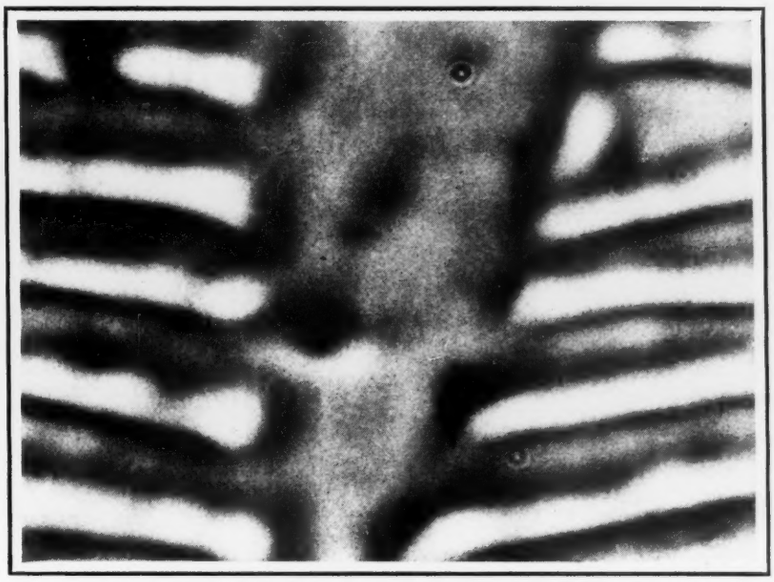


Fig. 1. Appearance of Steel magnified 15,500 Diameters

To cite another interesting application, a manufacturer in this country wished to duplicate a certain foreign article for American manufacture. All he had as a foundation was a tiny bit of steel less than an inch in size, from which it was necessary to learn its exact chemical composition, the internal structure, in order to determine the heat-treatment to which it was subjected in manufacture, the angles at which the tools that cut the article were made, and how to make these special tools if any should be found necessary. After three months, the complete story of manufacture was traced, and new methods and machines were suggested which turned out a superior product.

First the tiny sample was split in half. One piece was then annealed or softened so that the steel could gradually assume its normal structure. Examination under the microscope revealed the chemical constituents, and the kind of steel used. The other half of the sample was then enlarged and photographed, to determine what heat-treatment had been given it. From these samples the method of manufacture was prescribed, as well as the type of steel necessary.

A photograph, at 1000 diameters, of a sample of abnormal steel is shown in Fig. 2. The large dark thumb-print patches are individual minute grains. The surrounding white streamers are the grain boundaries. In normal steel, these are continuous instead of being broken up as shown. When iron first begins to crystallize at high temperatures, the crystals assume typical fir tree designs, as shown in Fig. 3. These are known as "dendrites." When the iron cools further, a second crystallization destroys these and gives a granular structure. This picture was taken of a spot in which this dendritic structure was preserved by segregated impurities.

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INDUSTRIAL MOTION PICTURES FOR CHINA

American industrial films could, according to Julean Arnold, United States Commercial Attaché in China, be used to advantage to show the Chinese people how American products are made and give them a picture of industrial conditions in this country. This, in turn, would stimulate the interest of the Chinese in mechanical developments. These films can be handled through the Bureau of Foreign and Domestic Commerce, but it is understood that the films must not be out-and-out advertising films designed primarily to sell specific goods, but should have an educational value. Nevertheless, out of a number of commercial films, a composite film could often be constructed that would be educational and at the same time carry the message of American industry. Ernest F. DuBrul, general manager of the National Machine Tool Builders' Association, Provident Bank Building, Cincinnati, Ohio, is interested in learning what has been done in the making of industrial films in the machine tool industry and whether a composite film could be produced from such films as have already been made that would be of publicity value to the machine tool industry as a whole, in connection with Mr. Arnold's suggestion.

Fig. 2. Abnormal Steel Structure magnified 1000 Diameters; the Thumb-print Patches are Individual Grains

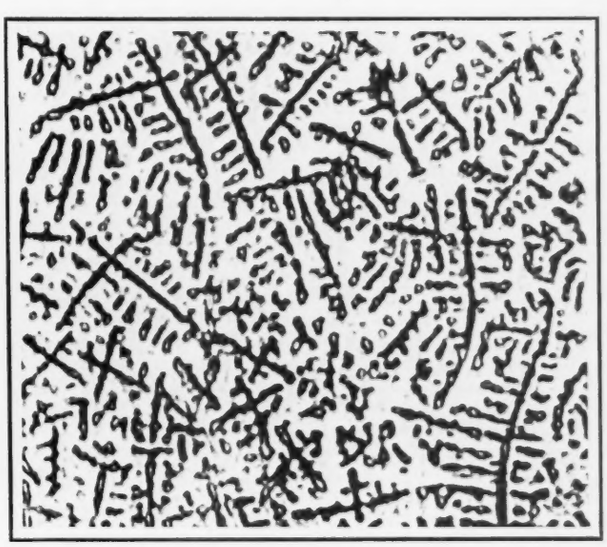
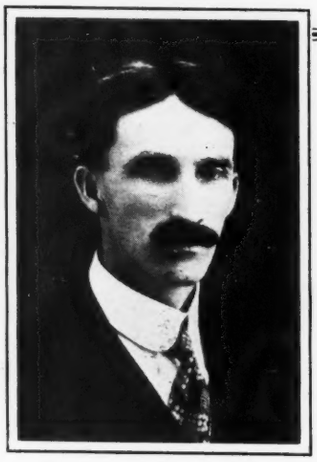


Fig. 3. The Fir Tree Designs at the Beginning of Crystallization at High Temperatures

Universal Center Drilling Jig

By HENRY SIMON

THE center-drilling of cylindrical pieces constitutes one of those minor problems of toolmaking that can at times assume formidable proportions. The accurate cross-drilling of a number of interchangeable pieces, for instance, is often a difficult job. When it is further required that these pieces closely fit other pieces cross-drilled to match them, the difficulty is greatly increased. Also, when the pieces are intricate and expensive, and the cross-drilling, which is usually the last operation, must be exact or the piece is spoiled, the simple and brief center-drilling operation becomes an item of great importance.



HENRY SIMON was born in 1882 in the small-tool manufacturing center of Schmalkalden, Germany, where he grew up in an industrial atmosphere and early became acquainted with the processes of mass production. Upon leaving high school, he entered the wholesale tool distributing business, and later held a semi-technical position with the agency for the Hammond typewriter in Central Europe. After four years at this work, he went to Oxford, England, taking a two years course of study at the University. Mr. Simon came to America nineteen years ago, settling in California. He has invented and patented a number of devices, including some tools for automatic screw machines. For the last six years he has been associated with the Simon & Skidmore Manufacturing Company, Santa Ana, Cal., maker of magazine tools and of automatic screw machine products. His mechanical knowledge has been largely acquired through practical work, close observation, and reading. He is a strong believer in self-instruction, and considers it a superior way of acquiring knowledge.

Important Features of Design

Dependability and automatically assured accuracy were chief among the points kept in view in the design of the center drilling jig here illustrated. These are only part of its desirable features, however, for it is even more remarkable for its wide range of adjustment, the rapidity with which it can be changed to accommodate large or small pieces of different sized drills; and the wide and complete range of drill sizes it will handle. In addition, it permits the performance of some rare but difficult operations, such as, for instance, off-center drilling of cylindrical work to close dimensions, and is readily applicable to the handling of non-cylindrical parts. While not in any way intended for production, one of its strong points is the accurate repetition of work on duplicate parts.

The device consists essentially of a hardened tool-steel disk *A*, Fig. 3, having near its periphery a series of holes which serve in place of separate bushings, the disk being capable of being indexed, and adjustable up and down in a base provided with means for locating and holding the work.

When a wide range of work is to be handled, more than one disk will have to be used, the construction of the jig making the disks instantly interchangeable. In the particular one illustrated, four disks are used to provide for the complete range of drill-gage sizes from 1 to 60 and from 1/64 inch to 3/8 inch by sixty-fourths. In addition to the drill-guiding holes, each disk contains a single locating hole, the function of which will be explained later. Diametrically opposite each hole is a shallow groove formed in the face of the disk for registering and holding the disk in indexing. Each disk is mounted on a hardened tool-steel stem, to which it is held by a press fit.

The base *B*, Fig. 3, consists of a block of cold-rolled steel ground square and parallel on all six sides. About midway of its length, this block is pierced by a reamed hole which receives the stem of the drill-guide disk with a snug sliding fit, and back of this hole a deep and narrow slot seats the index-dog *C*. This dog is pivoted near its lower end, and pressed toward the face of the drill-guide disk and into engagement with the slots in the face of the latter by a spring *D* concealed in a hole drilled in the rear end of the block.

Methods of Locating and Holding Work

At its front end, the block or base *B* is formed with a large cross-slot. The location of this slot in respect to the axis of the drill-guide disk is determined by the radial distance of the holes in the drill-guide disks. The work-holding means consist of one or more V-blocks or special holders which can be instantly removed or secured in position by two headless set-screws let into the front wall of the slot. Between these two screws is located the work-holding clamp *E* which can be adjusted up and down, or turned in a similar manner to the drill-guide. A length gage *F*, movable in a direction parallel to the center line of the slot and capable of considerable adjustment, completes the major features of the base.

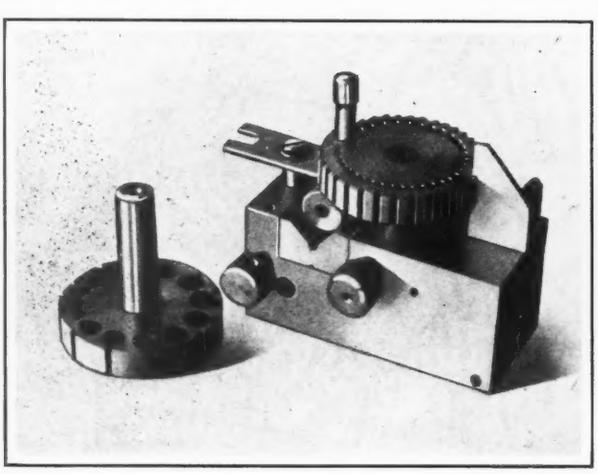


Fig. 1. Drilling Jig and Drill-guide Disk for Large Drills

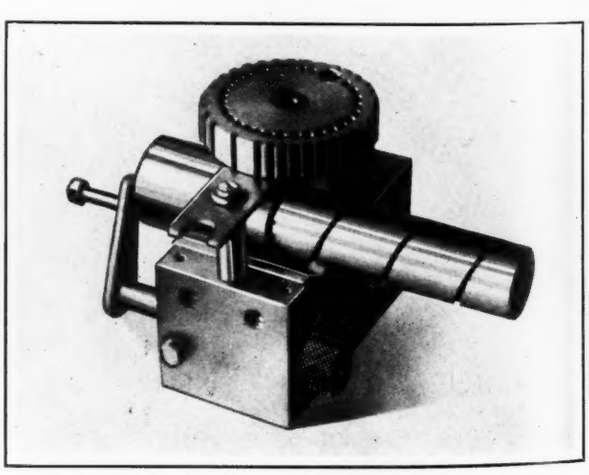


Fig. 2. View of Jig showing Locating Stop and Clamp

The drill-guide, work clamp, and length gage are each locked in place by a brass plug formed to fit its respective stem, and actuated by a screw. In the case of the drill guide and work clamp, the lock-screws are formed with knurled heads for quick adjustment, the heads being also provided with holes for the use of a pin in cases where a very rigid hold is required.

Important accessories are the center *G* and the locating or "sight" bushing *H*, both of which are used in the locating hole in the drill-guide disks. The center is made with a point having a 90-degree included angle, the opposite end being knurled for a short distance, and it can be used to center-mark the work, although its main purpose is the locating or "feeling" of punch marks or lines already made for the purpose of centering them on the jig. The sight bushing serves a similar purpose, and is used either alone or in conjunction with the center for locating marks that would otherwise be difficult to find. It consists of a tube formed with an enlarged central chamber and a small hole in each end, and its principle is the same as that of the sights of a gun. By its use it is possible to align the work by eye rapidly to within about 0.005 inch.

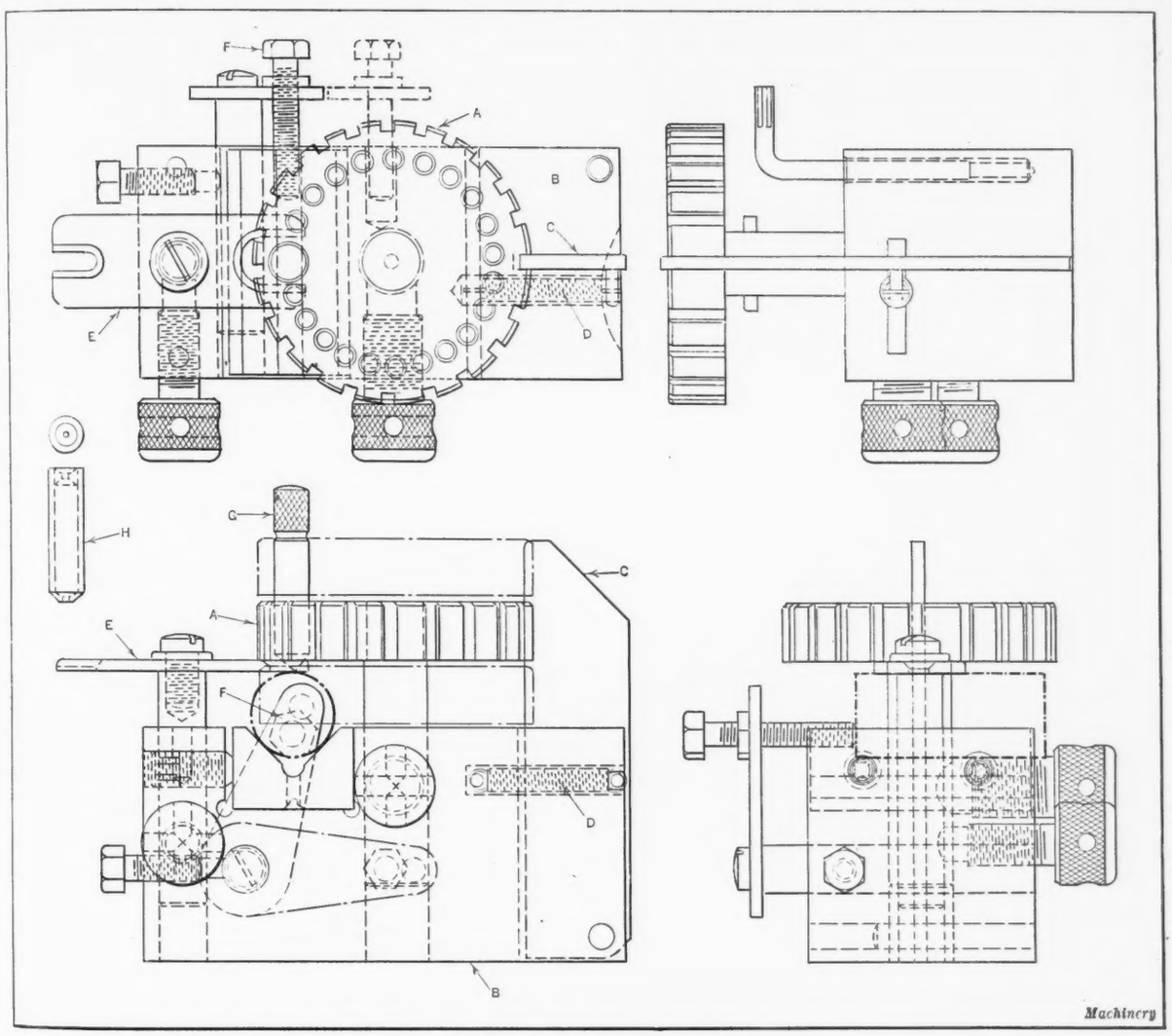


Fig. 3. Assembly Views of Universal Center Drilling Jig

Points on Building Jig

In order to insure the success of the jig, there are some points in the making of it, as well as a number of constructional details, that are important. The most difficult task is the making of the drill-guides. Before these can be finished, the stems for them must be made. These should be made from tool steel, turned on centers, hardened, and ground. The disks themselves must be made from a high-grade non-shrinking steel. After they have been blanked out, bored, and finished, a circle representing the centers of the drill holes should be drawn on one face before the disk is removed from the lathe. On this circle, the location of the holes is laid out, the rule being that there must be a minimum distance of 1/8 inch between the holes, or in other words, the center distance from hole to hole is equal to the sum of the radii of both holes, plus 0.125 inch. The disks are then transferred to the miller, where a shallow groove, 3/32 inch deep by 1/8 inch wide, is cut in the periphery opposite each prick mark.

The disks are next mounted on their stems. A temporary center drill-guide, consisting of a rectangular piece of flat stock is mounted in front of the work-holder slot, the work clamp being removed and for the time being replaced by a cap-screw by which the temporary guide is firmly drawn up to the face of the block, while two dowels prevent it from creeping. A hole, corresponding as to position with the intended working center of the drill-guides, and in size exactly with the locating holes in the latter, is bored in this piece. The disk is next indexed, clamped, and center-marked at every position by means of the regular center, which has already been described. When all marks have been made, the stem is pushed out, and the disk transferred to the drill press.

In forming the small sized holes, from No. 60 up to No. 35 and from 1/64 inch to 5/32 inch, a portion of the hole is counterbored with a larger drill. The procedure in making the holes is to first drill the small hole to size and to the intended depth, then to reverse the disk and drill with the larger sized drill to meet the first hole. In the case of the

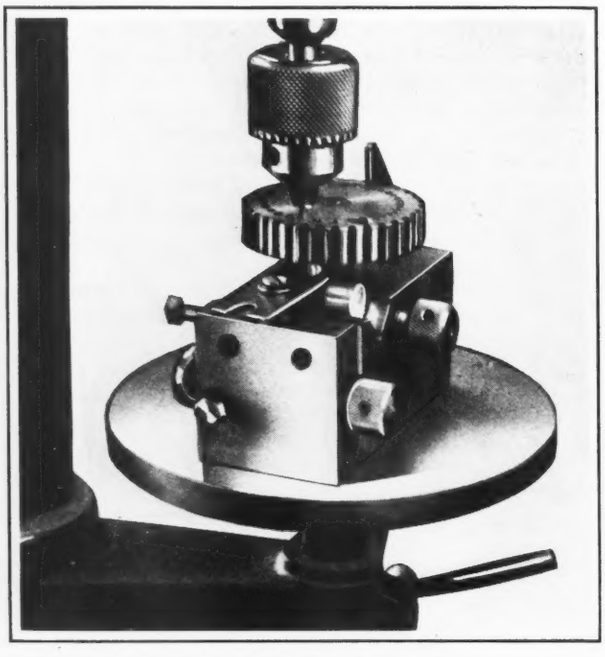


Fig. 4. Method of drilling Cross-hole in Pin

medium sized holes, the disk is first completely pierced with a drill a few thousandths smaller, and then sized with the drill for which it is to be used. The larger sized holes are best made by putting the disk on the faceplate and indicating and boring the hole to size. As a final operation, the upper face of each hole is slightly countersunk, and the disk is then ready for heat-treatment.

In heating the disks for hardening, they should be brought up to heat very slowly, especially at first, as in view of the many holes and sharp-cornered slots, cracking and deformation are likely to occur. The disks should then be drawn in oil or some other liquid bath at about 350 degrees F., for thirty minutes, and then allowed to cool slowly.

Machining the Base

The base block *B* should be ground square and parallel on all six sides before the work on it is done, as it will be found that time is thereby saved in aligning the various holes. In the construction of the entire jig as illustrated, the practice of leaving no blind holes has been adopted. This makes it possible to get at any of the sliding member from the back side. As the accuracy of the jig depends upon the central hole for the drill-guides, this should be bored and reamed on the lathe.

The work-holder slot must be made with equal care. As shown in the illustration, the corners of this slot are undercut by drilling them out before milling. This not only prevents chips from interfering with the proper seating of the work-holding devices, but also allows the slot to be refaced by grinding at any desired time. The only other part of the block that requires any particular care in the making is the index-dog slot, which must be of uniform width, parallel with the sides of the base, and exactly radial with the drill-guide stem hole.

It should be noted that the work-holder receiving slot is wider than the V-blocks and other work-holding devices, thereby leaving a narrow gap in front when the block is in position. This feature renders possible cross-drilling off center on the work to a predetermined distance, as will presently be shown. The work-holders themselves consist of a set of three V-blocks, Fig. 6, each formed with two grooves in opposite faces, and with holes of different sizes passing through the block at several points in the grooves, in order to permit the safe passage of drills and reamers entirely through the work. These blocks are also made from tool steel, hardened, ground on all registering faces, and trued up to align with the drill-guide.

Versatility of Jig

The use of this jig not only permits the rapid handling of a wide range of work, such as falls to the lot of every toolmaker to perform, but it will be found to have a remarkable versatility in spite of its simple construction. By merely turning a thumb-nut, the drill-guide is instantly adjusted from work of the smallest to the largest size, while a single turn instantly indexes the disk at the desired hole. The work-holding clamp permits the drill-guide to be kept a distance away from the work when desired, or it can be eliminated by turning it parallel to the work when it is desirable to have the guide rest directly on the work.

By the use of the center and sight tube, the work can be quickly and accurately lined up. A particularly valuable feature is that the drill-guide can be instantly removed at any moment without disturbing anything else. This renders it possible to examine and check up on the work at any stage, or to perform operations beyond the range of the drill-guide, such, for instance, as counterboring a hole to a larger size than the jig will handle, while the work is still securely clamped in correct alignment. The design of the work-holding means and the method of fastening them still further increases the range of action. The V-block and the end stop can be adjusted and clamped at practically any lateral position desired beyond the center of the jig. Holes can also be drilled at an angle other than 90 degrees to the axis of the work by tipping the work-holder.

Drilling Holes off Center

Another feature that often is of great value is the ease and precision with which holes can be drilled off center through a piece. One application of this feature is in the matching, on a new piece, of holes that must correspond exactly with holes already existing in an old piece and drilled off center. A common example of this frequently exasperating condition is that of a sleeve pinned on a shaft, with the pin-hole off center. It is not difficult to measure the amount of error, and by the use of either one of two methods, it is an easy matter to match the old work. One way to accomplish this is to space the work-holder forward

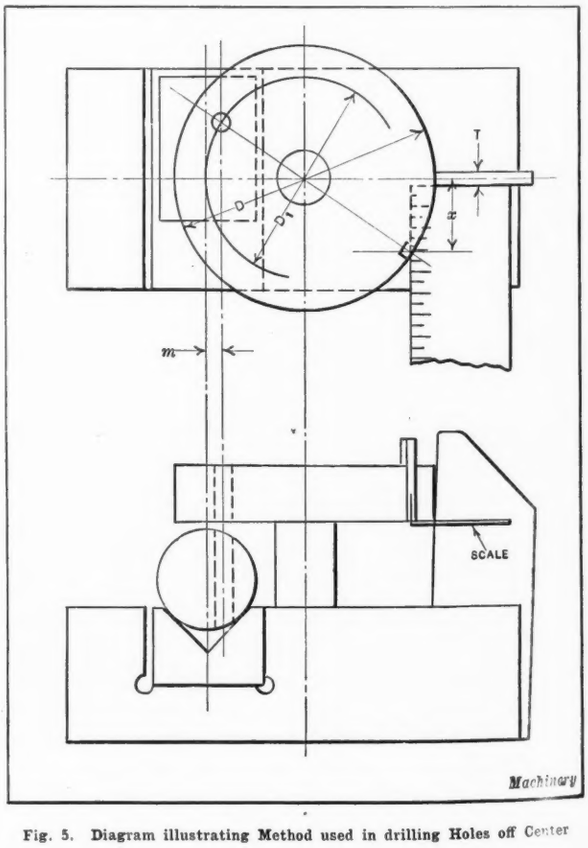


Fig. 5. Diagram illustrating Method used in drilling Holes off Center

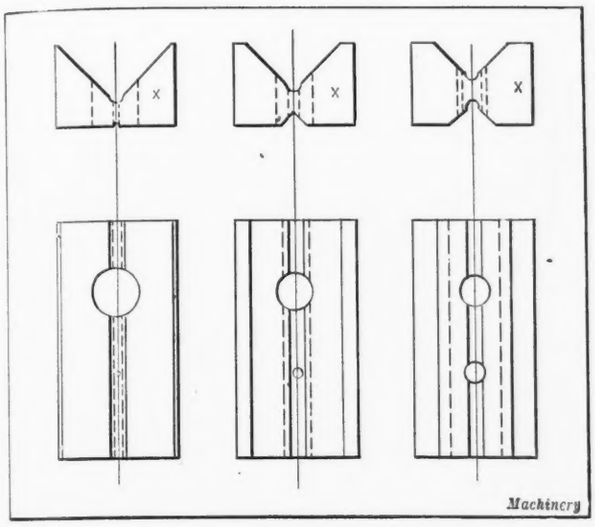


Fig. 6. Set of V-Blocks used with Universal Center Drilling Jig

the required amount by the use of a size block. The method shown in Fig. 5 requires no size blocks and also gives a wider range, but a short calculation must be made. It consists in swinging the working center of the drill-guide out from the working center of the jig by an amount sufficient to cause the necessary offset. The amount by which the disk must be turned is measured in terms of the chord of the periphery of the disk, starting from one face of the index-dog, and is found by the formula:

$$x = \frac{D}{D_1}\sqrt{m\ (D_1 - m)}$$

where

D_1 = diameter of circle on which centers of drill-guide holes are located;

D = diameter of periphery of drill-guide;

m = amount of offset required;

x = distance from plane through center of index-dog, and radial to disk, to point on periphery of guide disk corresponding to center of index slot of hole to be used, as indicated in Fig. 5.

If, for instance, it is desired to offset a hole by an amount of 3/16 inch, and the diameter of the disk is 3.000 inches, while the radius of the drill-guide holes is 1.125 inch, then

$$x = \frac{3000}{2.250}\sqrt{0.187\ (2.250 - 0.187)}$$

$$x = 0.828$$

This measurement equals the amount shown on the scale with the end placed against the side of the index-dog, to the center of the respective notch, plus one half the thickness T of the index-dog. As the measurement must be taken to the point over the notch corresponding with the periphery of the disk, it is best to use a small rectangular pin, with its outer face corresponding to the periphery of the disk, and the center of the slot marked on it. This pin is lightly held in the notch in the manner shown in the lower view of Fig. 5. It should be made an easy fit in the notch, and by slightly springing it laterally, it can be made to retain its position and yet be easily slipped into place. In addition to the several V-blocks shown in Fig. 6, various vises, clamps, and other holders can be made to suit requirements.

* * *

INDUSTRIAL AND BUSINESS STATISTICS

In his annual report to the Secretary of the Department of Commerce, the Director of the Census of the United States points out that the value of statistics concerning the production, consumption, and stocks of commodities is now generally recognized, and there is a continually increasing demand for such statistics. He, therefore, renews the recommendation made in his report for 1924, that specific legislation be enacted authorizing their collection and compilation.

REDUCING MACHINING COSTS ON STEEL CASTINGS

Some valuable information on the causes and prevention of high machining costs when handling steel castings was given in a recent report issued by the Electric Steel Founders' Research Group. The causes for excessive machining costs may be divided roughly into two classes. The first of these to be considered includes causes that can readily be eliminated in the cleaning room at the foundry. Defects in this group may or may not be indicative of carelessness in melting, molding, or core-making. They may be the result solely of indifferently performed finishing operations, which are an important factor in the production of "quality" castings.

Inadequate Cleaning Operations

Poorly performed cleaning operations leave residues of molding sand and heat-treatment scale on surfaces that may be machined. Either of these materials is a cause for reasonable complaint by the machinist. Sand is especially objectionable because of the decided dulling effect on the cutting edge of the tool. Difficulty from this source is intensified when the sand, because of an unsuitable facing or core mixture for the job, has become so firmly attached to the casting by fusion, that ordinary cleaning-room methods are ineffective. Scale formed in annealing or normalizing operations is generally removable without difficulty on accessible members of castings.

Careless chipping and grinding operations accompanied by poor inspection results in fins at core joints and at parting lines. The inadequate trimming of gates and risers also leaves projections.

Faults in Casting Design

Surfaces may be warped, due to incorrect casting designs or molding procedure. Castings occasionally show the results of shifts, due to bad condition of flasks. Offsets caused by improper registration of cope and drag sides of patterns produce the same effect. Some of these conditions can be remedied in the cleaning room at the foundry. All of them should be eliminated from high-grade castings, particularly when they may, to any degree, interfere with the application of jigs and the laying-off or setting-up operations preparatory to machining. The operator of a planer has a right to complain if a casting to be surfaced cannot be quickly and tightly secured for this purpose, because of an obstruction that makes a rocking seat on the bed of the machine tool.

Machining Qualities of Metal

Probably the most serious causes for excessive machining expense are not those that have been mentioned, but are

Illustrations showing Effect of pouring Steel Casting with Large and Small Ends Up

distinctly related to molding and melting procedures, as distinguished from cleaning methods. Furnace practice may occasion trouble in causing hardness, discovered only when castings are being machined. Small areas in which the metal is perceptibly harder than in the other portions may result from unskillful use of aluminum, employed for deoxidizing the steel. A compound including this element may be formed and segregated, having characteristics that resist tooling operations.

There may be a serious lack of uniform distribution of manganese, used both for deoxidizing and alloying purposes. In such cases, the excessive proportion of this element in some castings has very injuriously hardened them. Castings that because of hardness retard machine work leave evidence, after such operations are completed, that trouble has been experienced.

Cored Holes

Frequently castings are provided with cored holes that are intended to be finished to exact diameters by drilling or reaming. Improper placing or securing of cores, and the use of cores that are not of perfect shape, results in the formation of holes which, when machined, may force the tool to deviate from the desired direction. This causes the tools to break or, at least, results in an inaccurately positioned hole. The penetration of a drill into a large blow-hole or shrinkage cavity in the body of a casting may have the same effect as is produced by eccentrically cored holes, and may necessitate discarding the casting.

Prevention of Cavities

Cavities may sometimes be prevented by actually reducing the metal in the riser, redesigning the riser and pouring the casting in a different position. The riser on the cone-shaped casting shown in the accompanying illustration, which was poured with the small end up, weighed 116 per cent as much as a sound casting itself, while the shrinkage head on a casting from the same pattern made with the large end up, as shown in the view at the right-hand side of the illustration, weighed 44 per cent as much as the casting. Unskillful foundry practice, resulting in cavities discovered in machining, occasions a large proportion of such complaints as are registered on account of the unnecessary labor required in machining.

Slag Spots

Slag spots are among the chief sources of difficulties experienced in machining small steel castings. Unless the foundry workmen are very skillful, foreign material having the physical characteristics of slag will find its way into the castings. Relatively clean metal, as produced in the furnace, may, when poured into castings under unfavorable foundry conditions, produce many slag inclosures that can be seen without magnification. The causes for these two defects are thus seen to differ.

The effect of slag inclosures is particularly objectionable in the case of machining operations that come in contact with these defects. The tool used in machining is affected in much the same way as if forced against a coarse abrasive material. This is naturally followed by an unsatisfactory finish resulting from the use of a damaged tool on parts of the casting subsequently machined. The removal of the surface of the inclosure always leaves exposed an unsightly area, and frequently causes uncertainty as to the depth of the defect and the soundness of the affected portion of the casting. This generally necessitates careful probing, often followed by several refinishing operations, if the casting is not discarded.

Care in Pouring

Despite all precautions taken in the pouring of very hot steel from ladles lined with the best materials properly prepared, there is some fluxing action on the lining, resulting in slag which, if carefully skimmed to prevent entry into the mold, will ultimately solidify around the lining of the hand ladle. Each of these ladles or pots is employed throughout the pouring of a heat into small molds, and is, therefore, filled with steel numerous times without getting cold. With every repeated use of the shank ladle lining, there is generally an increase in the slag deposit. Progressively this adheres to the side of the pot, partially solidifies, becomes liquid, increases in volume, and, on again adhering to the ladle wall, begins a new cycle of the same kind. It will be seen from the foregoing that there should be a systematic regulation as to the number of times a shank ladle lining is used, in order to prevent the formation of an excessive amount of slag.

The manufacture of large castings is not accompanied by the use of pots or shank ladles. Consequently, opportunities for carrying slag into large castings are reduced by this factor, as well as by the important one of lower initial temperature.

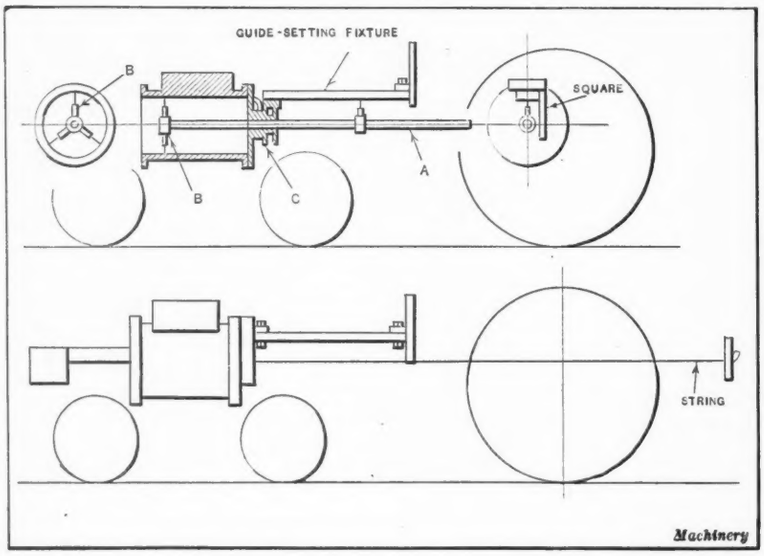
* * *

ALIGNING LOCOMOTIVE CYLINDERS AND CROSS-HEAD GUIDES

By F. RATTEK

It was with interest that the writer read the article in October MACHINERY on page 122 entitled "Aligning Large Cylinders." In the main division shop of the railroad where the writer learned the machinist's trade, the apprentices were thoroughly instructed in the use of the aligning string for setting the cylinders of the locomotive in proper relation to the frames and also for setting the cross-head guides in their proper positions with respect to the cylinders. In another shop where the writer was employed, the guides were located by the device shown in the upper view of the illustration. The long tube *A* has a spider *B* attached to one end, with means for adjusting the tube to line up with the center of the cylinder. This tube is centered in the back cylinder head by a gland *C* which fits in the stuffing-box. The adjustment of the spider *B* is obtained by means of screws which are located at the end of each arm.

All the fourth-year apprentices could, by the use of this fixture, set the locomotive guides quite accurately. Sometimes a boy, at the termination of his apprenticeship, would go to other shops, and when given the job of setting the cross-head guides would experience difficulty or failure. On looking around for a guide-setting fixture such as he had used as an apprentice, he would be very much surprised or puzzled when the foreman reached down in his desk and pulled out an old ball of string saying, "Here's our guide-setting fixture, boy; hustle it out."



Diagrams showing Methods of aligning Locomotive Cylinders

IMPORTANCE OF SMALL TOOLS IN PRODUCTION

By W. T. READ, Vice-president and Treasurer, Morse Twist Drill & Machine Co., New Bedford, Mass.

In September MACHINERY, an article appeared entitled "The Future of the Machine Tool Industry," which called attention to the fact that, with the advent of high-speed steel, machine tool manufacturers have been forced to redesign and remodel many of their machines to take care of the increased capacity of the small tools that were used in connection with the machines themselves. The article further called attention to the fact that in the last few years the required redesigning has been quite well cared for by the machine tool manufacturers, so that now the small tool makers are being pressed for more efficient tools to take advantage of the capacities of the machines themselves. The small tool manufacturers in general have been cognizant of this change in conditions, and have been working for some time to improve and bring out tools that would keep abreast of the production requirements.

In this connection it has been noticeable, in looking over numerous articles in trade papers, that stress has been laid upon the new machines and machine tools offered to the trade at large, with various improvements and opportunities for increased production, which is practically the only basis on which there is much demand for new machinery in these days. It seems to the writer that very often the fact is lost sight of that even with this new equipment, the actual production of work that a given machine will turn out is dependent very largely upon the small tools used in the machine, and while much thought, time, and attention is given to the selection of the machinery, there is, except in very large production shops, and in rather remote instances, very little real investigation made into the actual results to be obtained year in and year out from any given small tool. Of course, the cost of the tool, in proportion to the cost of the machine installation, is small, but if an adequate return is to be had from the large investment in machinery, it is absolutely necessary that time and thought be given to the selection of the small tools. These tools should be bought absolutely on a quality basis, rather than on the basis of first cost, as many times the slight difference in cost on the original purchase will return large dividends in the matter of increased production, freedom from trouble, and uniform and accurate work.

In view of this condition, and the fact that in many instances the machines are capable of driving the tools to maximum capacity and beyond, it is more important than ever before to give thought to the careful selection of the tools themselves, as upon this selection depends very largely the degree of efficiency obtainable with modern shop equipment.

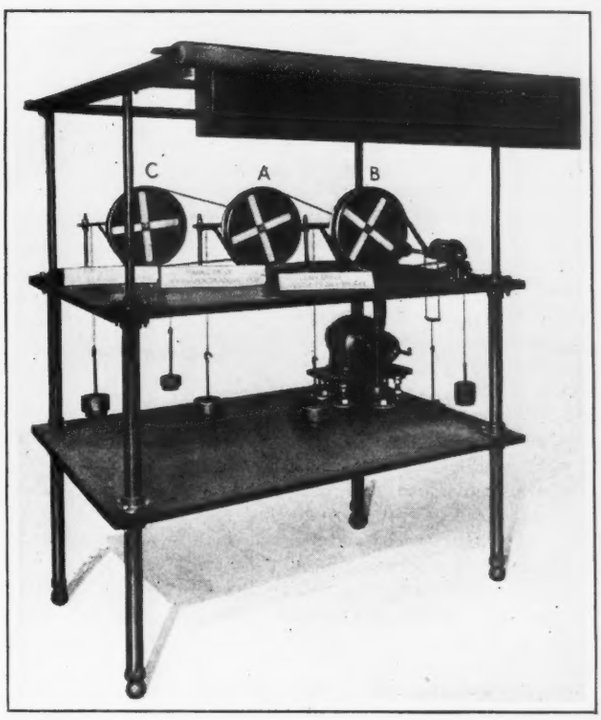
* * *

VISUAL COMPARISON OF BELT SLIP

The short-center or Lenix belt drive differs from the ordinary long-center open-belt drive as regards the following features: With the Lenix drive, the driving and driven pulleys may be placed close together, and a free or idler pulley hinged adjacent to the smaller pulley bears on the slack side of the belt. The belt is of such length that the loose side is within a few inches of the tight side, and the initial tension is due solely to the weight of the hinged floating pulley. This arrangement permits of high pulley ratios, high overloads, minimum belt slip, and low belt tension. The large arc of belt contact with both pulleys increases the belt grip for a given initial tension and belt size. As the belt stretches, due to the application of a load, the tension in the slack side is automatically maintained by the hinged pulley.

The accompanying illustration shows a device used by F. L. Smidth & Co., 50 Church St., New York City, to demonstrate visually the relative slip of a short-center drive and an open-belt drive. A motor-driven lineshaft carries three small pulleys of equal diameter, which are connected by belts to three large pulleys, also of equal diameter. The timing pulley *A* runs free, while the other two pulleys are fitted with Prony brakes. The brake pulley *B* is driven by a short-center belt drive, and pulley *C* by an ordinary long-center drive. The frames carrying the large pulleys are balanced upon pivots and counterweighted, so that equal bearing pressures can be produced on each pulley bearing, and approximately equal initial tensions in each belt.

Upon the web of each of the large pulleys is marked a white cross. A small commutator switches current for lighting a neon tube four times for each revolution of the center or timing pulley. Ordinary incandescent lamps are unsuited for this purpose, because of the comparatively long time it takes for the filament to reach full brilliancy and to die out. The action of the neon tube is absolutely instantaneous; hence, the clear picture of the relative motions of the three crosses. If the two pulleys carrying Prony brakes are running at the same speed as the free pulley, the crosses on these pulleys will always be illuminated when in the same position and will appear to be standing still, but if the two



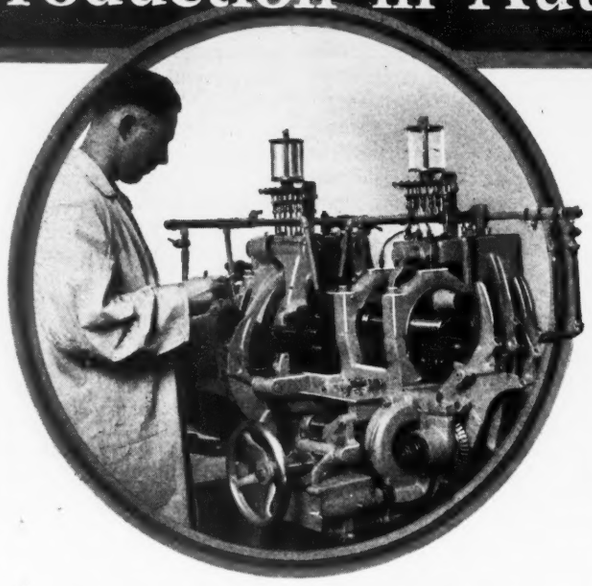
Apparatus for demonstrating Belt Slip of Open Drive as compared with Short-center Drive

brake pulleys are rotating, say, 1 per cent slower than the timing pulley, each cross will then be 0.01 of the circumference of the circle behind the position occupied at the time of the previous illumination, and will appear to the eye to be rotating backward. This phenomenon is frequently noticed in moving pictures where a locomotive, for example, is seen pulling into the station with the wheels apparently revolving backward.

Starting with equal pulley ratios and equal belt thickness, at no load, both the short-center driven and the long-center driven crosses will stand still. On applying a light load, both crosses will start to rotate slowly backward, the cross on the long-center drive pulley rotating a little faster than the cross on the short-center drive pulley. However, as the load increases, without changing the belt tension, the cross on the long-center drive pulley will rotate backward at an increasing rate, while the cross on the short-center drive pulley will rotate about as before. By the time the slip on the open drive has reached 3 or 4 per cent, the slip on the short-center drive will still be within 1 or 2 per cent. If the load is still further increased the open belt drive will jump off at a load where the short-center drive still has a large reserve capacity.

Devices of this kind are useful for demonstrating engineering facts that otherwise might cause many arguments.

Rapid Production in Automatics



Typical Examples of Work Performed in Small-size Multiple-spindle Automatic Screw Machines

By W. S. DAVENPORT, President,
Davenport Machine Tool Co., Inc., Rochester, N. Y.

MULTIPLE-spindle automatic screw machines are economically applied in the mass production of many parts on which a considerable number of cuts must be taken. When these machines are equipped with proper tools and the timing of the different cuts is correctly proportioned, high production rates are obtainable with correspondingly low machining costs. On the smaller sizes of multiple-spindle automatic screw machines, such as those built by the Davenport Machine Tool Co., Inc., Rochester, N. Y., the time required for producing parts from bar stock is generally a matter of but a few seconds, even though a tolerance of only 0.0005 inch may be allowed on the different diameters and lengths of the parts, provided they are correctly tooled. This article will describe the methods followed in producing a number of parts. In these machines there are five tool-spindles, opposing a like number of work-spindles, and there is a front tool-slide, a front tool-arm, a rear tool-arm, and a rear tool-slide. There may also be an overhead tool-slide, or slotting, milling, left-end threading, and other attachments. Each tool is controlled independently by a separate cam, and the travel of any tool may nearly always be adjusted to suit the job without changing the cam that governs the tool. This factor results in a great saving of time in changing the tool set-up of the machines. Throughout this article, the different indexed positions of the work-head spindles will be referred to as positions *A*, *B*, *C*, *D*, and *E*. The stock is fed to a stop as each spindle indexes from position *E* into position *A*.

Pieces Made in Three Seconds

At *A* in Figs. 1 and 2, is shown a brass binder post which is machined from 3/8-inch stock and cut off at the rate of one piece every three seconds. Both ends are threaded and one shoulder is knurled. In position *A*, two surfaces are turned on the work, as illustrated diagrammatically in Fig. 2, by means of tools held in a special head mounted in the tool-head spindle corresponding to position *A*. When the work has been indexed into position *B*, a circular forming cutter on the rear arm is swung forward to finish-turn every surface, while the projecting end of the work is pointed and held rigidly by a combination tool and support, mounted in the tool-head spindle of position *B*.

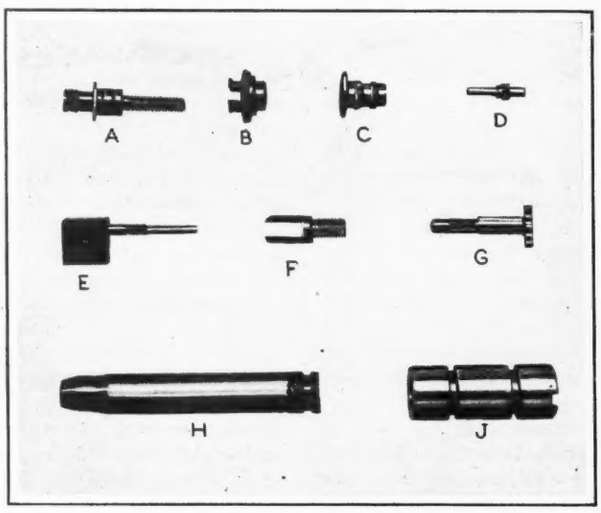


Fig. 1. Typical Parts produced in a Multiple-spindle Automatic Screw Machine in a Few Seconds

A thread-rolling tool on the rear slide is advanced to produce the thread on the left-hand end, after the work reaches position *C*, and at the same time a cutter in the tool-head spindle advances to counterbore surface *a*, as shown at *A*, Fig. 2. In position *D* the long thread on the right-hand end of the piece is cut by means of a self-opening die-head mounted on the tool-head spindle for this position. Finally, when the piece reaches position *E*, surface *a* is knurled by a knurling roll mounted on the respective tool-head spindle, and the part is cut off by a tool mounted on the front tool-arm. The spindle speed in this operation is 1800 revolutions per minute, which gives a surface speed of 190 feet per minute.

Another brass piece made in three seconds is shown at *B*, Figs. 1 and 2. End *a*, as shown in Fig. 2, is slotted, surface *b* is knurled, and end *c* is tapped. In position *A*, the projecting end of the work is centered by a drill held in a combination stock-stop and drill-holder, which is mounted on the corresponding tool-head spindle. Simultaneously, a forming cutter on the front cross-slide forms seven different surfaces. In position *B*, the piece is drilled the entire length through end *c* by means of a drill held in the tool-head spindle, and at the same time a sizing form cutter on the rear arm swings forward and sizes all turned and faced surfaces. This tool is provided with a roller which backs up the work on the rear side.

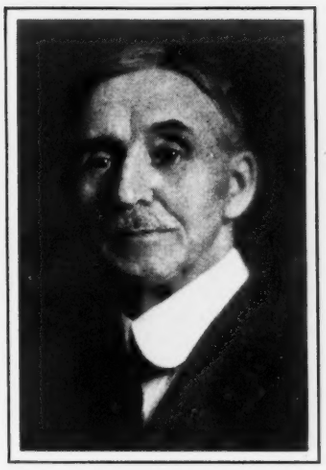
When the piece reaches position *C*, end *c* is tapped by a tap held in the corresponding tool-head spindle, and in position *D*, beveled surface *b* is knurled by means of rolls attached to the opposing tool-head spindle. Finally, in position *E*, the part is cut off by a tool mounted on the front tool-arm, and while this step is in process, the projecting end of the part is gripped in the collet of a transferring spider. This spider carries it to the front of the machine where slot *a* is produced by the milling cutter of a slotting attachment. The work-spindles of this machine also run at 1800 revolutions per minute.

Two-second Operations

The part illustrated at *C* in Figs. 1 and 2 is a brass cable release for cameras. This piece is produced at the rate of one every two seconds. The tool-head spindle opposite position *A* of the machine in which the operation is performed, is also equipped with

a combination stock-stop and centering tool, so that the projecting end of the piece is centered after it is fed forward the desired amount. Simultaneously, the part is rough-taper-formed, as may be seen in position *A* in Fig. 2, by means of a tool on the front cross-slide. In position *B*, a drill on the corresponding tool-head spindle drills a hole 0.173 inch in diameter for about two-thirds the length of the part. At the same time, a circular forming cutter on the rear cross-slide advances and finish-turns all surfaces, and faces the projecting end to length.

Another hole is drilled on the axis of the piece to a diameter of 0.113 inch by a drill in the tool-head spindle corresponding to position *C*. While this step is proceeding two narrow cylindrical surfaces are knurled by means of tools mounted on the



W. S. Davenport

WILLIAM S. DAVENPORT was born in 1861 in Williamstown, Vt., and educated in the district schools. While a boy on the home farm, he developed a strong liking for machinery, and not being able to purchase a lathe, constructed one from parts of old churns, mowing machines, etc. With this lathe he made patterns and built a steam engine. He began shop work in a button factory in Rutland, Vt., and later was employed by the Fairbanks Scale Co., St. Johnsbury, Vt., the Southern Scale Co., Rome, Ga., and the Brown & Sharpe Mfg. Co., Providence, R. I. He started with the latter firm as a machinist and advanced to the position of designer of automatic screw machines. Mr. Davenport formed the Davenport Machine Tool Co. in 1900 to market a machine that he had designed for automatically producing clock lantern pinions, the machines being built by the Morse Twist Drill & Machine Co., New Bedford, Mass. In 1907 and 1908 he operated a shop in Springfield, Mass., where the first Davenport five-spindle automatic screw machine was constructed, and then renewed the old association with the Morse Twist Drill & Machine Co. until 1917, when he again started a machine shop of his own. In 1919 the business was removed to Rochester, N. Y., and the Davenport Machine Tool Co., Inc., formed, of which Mr. Davenport is president and general manager.

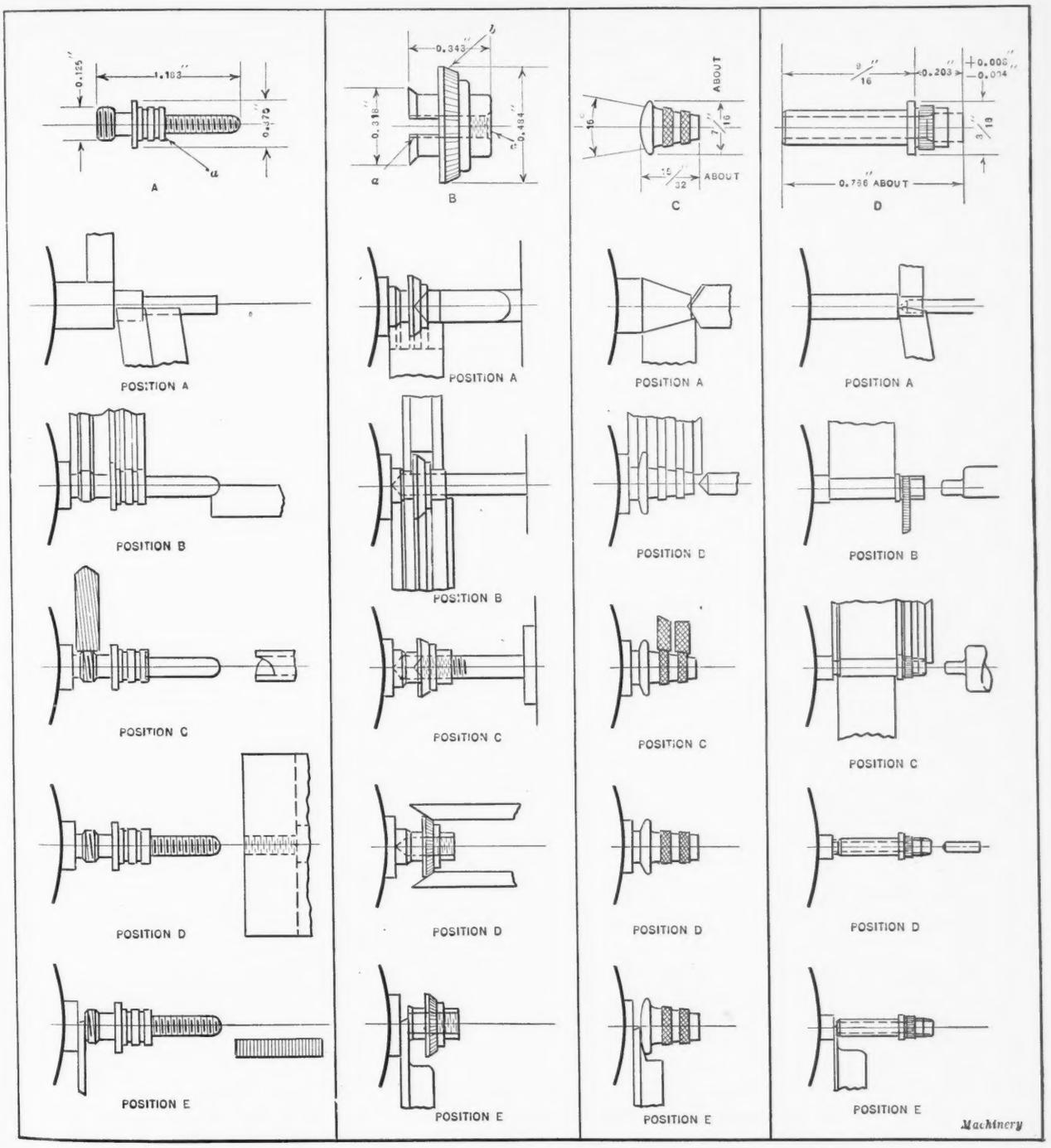


Fig. 2. Four Parts produced in Two or Three Seconds, and Tooling employed in their Production

rear tool-arm. In position *D*, the small hole drilled while the part was in position *C* is threaded by means of a tap held in the corresponding tool-head spindle. Finally, in position *E*, a small hole is drilled through the head of the part by a No. 51 drill held in the tool-head spindle, while a circular forming cutter on the front tool-arm cuts off the head end of the piece to a radius. In this operation, the spindle speed is 2400 revolutions per minute, which gives a surface speed of 300 feet per minute.

At *D* in Figs. 1 and 2 is shown a small piece made from 3/16-inch brass stock, also at the rate of one piece every two seconds. In the tool-head spindle opposite position *A* of the machine used for this operation, there is a holder that advances two turning tools and a No. 38 drill for turning the projecting end and drilling this end to a depth of about 3/16 inch. After the piece has been indexed into position *B*, a pilot on the tool-head spindle advances into this drilled hole to support the part during the turning of the left-hand end and the knurling of the enlarged end. The turning is accomplished by means of a forming cutter mounted on the rear tool-arm, and the knurling by means of a tool forced against the work by the front slide.

In position *C*, another pilot in the tool-head spindle enters the work to support it during the sizing of the various surfaces by a circular forming cutter attached to the rear tool-arm. This cutter is provided with a roller that backs up the front of the work during the cut. A No. 47 drill is used in the tool-head spindle of position *D* to complete drilling the hole through the piece, and in position *E* the part is cut off to length by a tool mounted on the front tool-arm. The spindle speed in this operation is about 2400 revolutions per minute, and the surface speed is approximately 120 feet per minute.

Piece Made from Rectangular Stock

At *E*, Figs. 1 and 3, is shown a brass piece having a head 7/16 inch wide by 0.234 inch thick, and a small-diameter shank that is off center. This piece is produced at an aver-

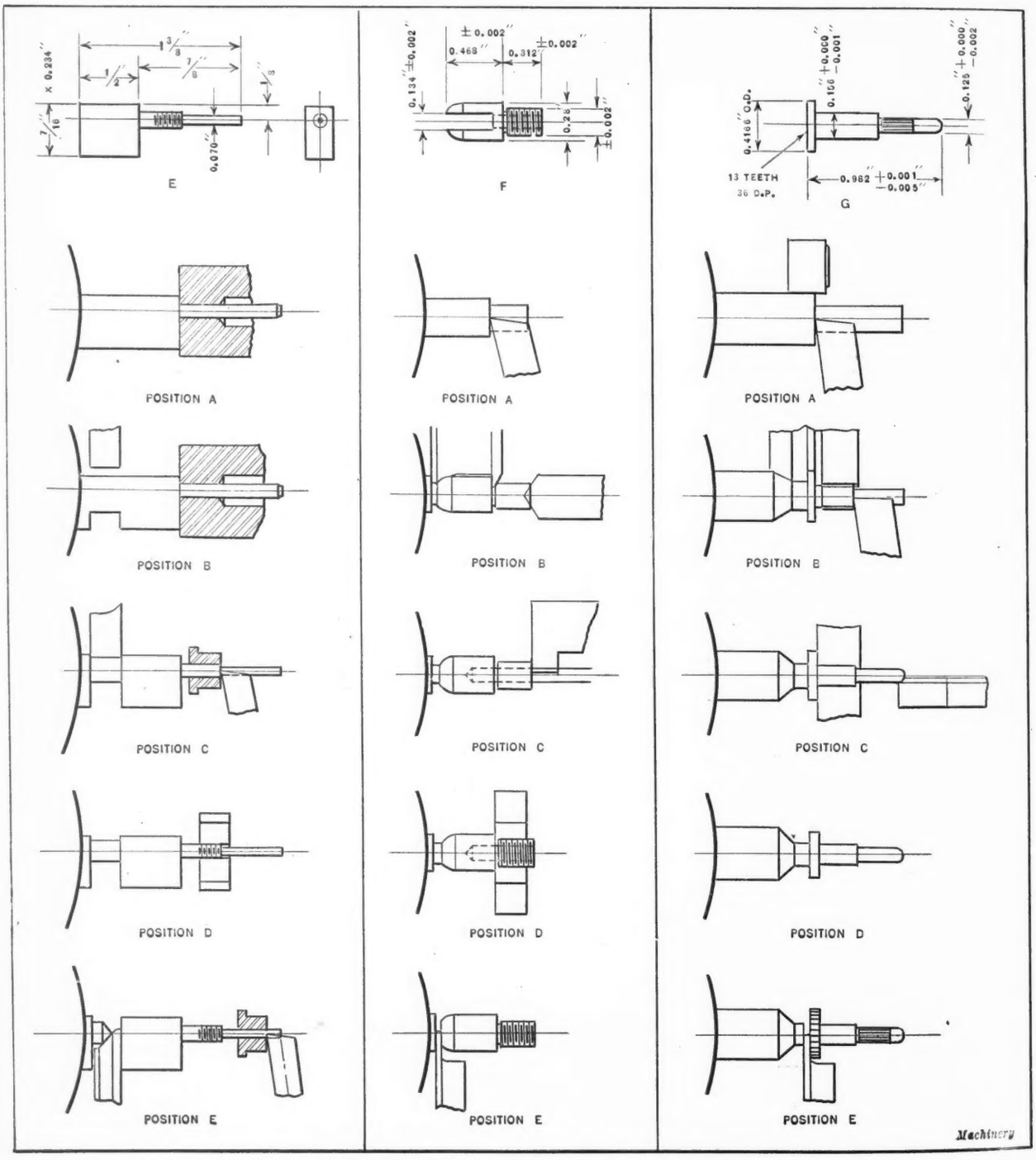


Fig. 3. Detailed Views of Pieces E, F, and G, and Tooling used in their Production

age rate of four seconds in a machine equipped with spring collets which hold the work off center the necessary amount. When the stock reaches position *A*, part of the material that is to be cut down to form the shank has already been removed by tools that operated while the preceding piece was being produced. In position *A*, a hollow mill attached to the corresponding tool-head spindle advances and rough-turns the shank to a diameter of 1/8 inch. Another hollow mill attached to the tool-head spindle of position *B* finish-turns the shank to the outside diameter of the thread, while a circular forming cutter on the rear cross-slide cuts down the stock on the opposite side of the head to start making the shank of the next piece. The second hollow mill is held in a floating holder.

In position *C*, the corresponding tool-head spindle is provided with a bushing that slips over the work shank as the tool-spindle advances, so as to support the part during the operation. A pointing tool, also mounted on this tool-head spindle, reduces the diameter in front of the portion to the right of the supporting bushing, which is later threaded. At the same time, a circular forming cutter on the rear tool-arm further reduces the stock on the opposite side of the head to continue making the shank of the next piece. The thread of the shank is cut by a die-head mounted on the tool-head spindle opposite position *D*. In position *E*, the end of the shank is pointed by a tool in the tool-head spindle, while the projecting end of the work is again supported by a bushing, and the part is cut off by a tool mounted on the front tool-arm. In this operation, the work-spindles revolve at 1500 revolutions per minute.

The small fork-shaped piece illustrated at *F* in Figs. 1 and 3 is also produced in four seconds. This is another example requiring the use of a slotting attachment. In position *A*, a box-tool on the tool-head spindle advances to turn the shank

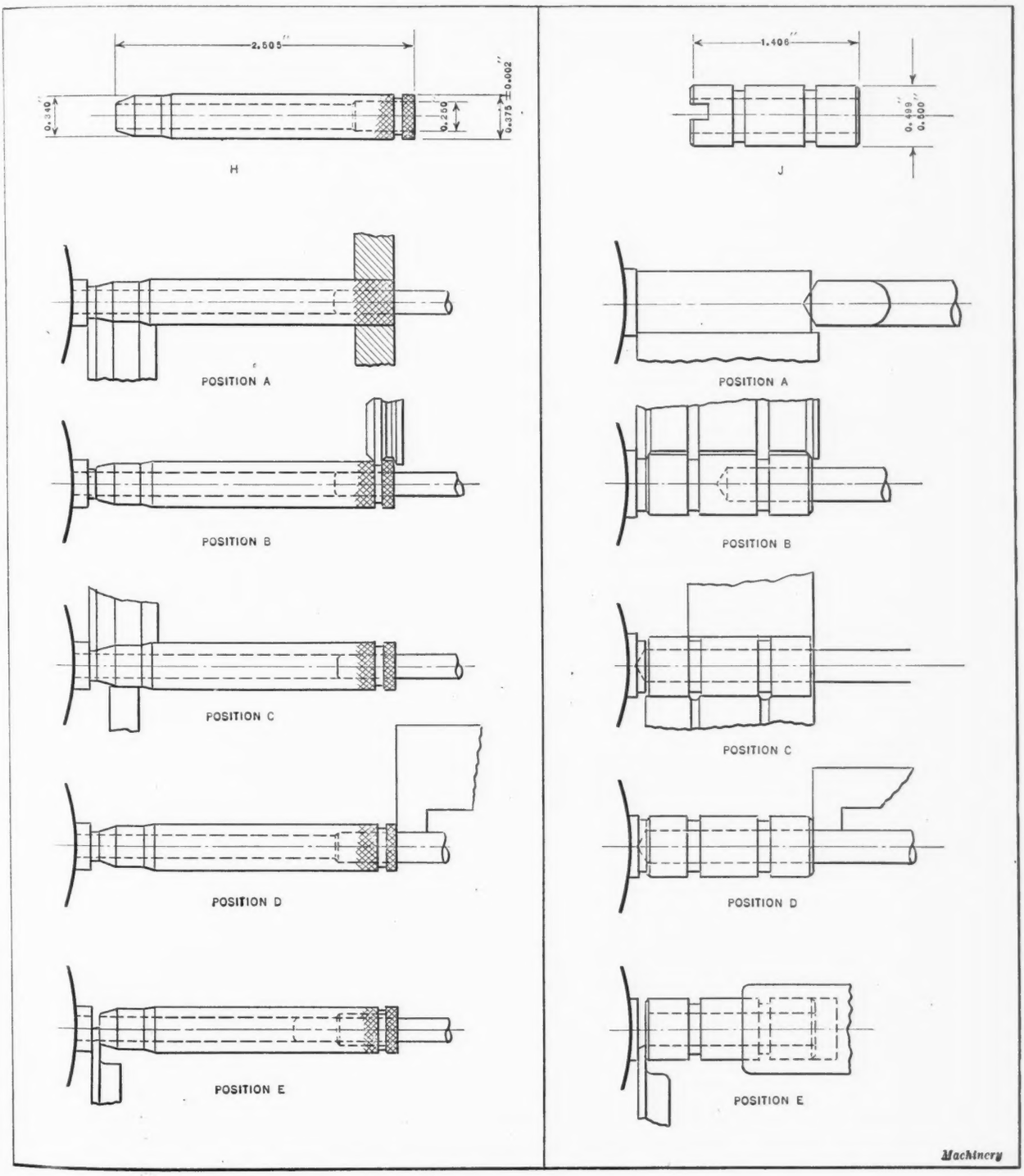


Fig. 4. Two Larger Examples and Consecutive Steps in their Manufacture

to the specified diameter. After indexing into position *B*, the projecting end of the work is centered by a drill mounted in the tool-head spindle, while the round head of the large end and a recess at the left end of the thread, are produced by a circular forming cutter mounted on the rear cross-slide.

In position *C*, a No. 30 hole is drilled through the shank and the end of the shank is faced by a drill and facing tool, respectively, which are mounted in a holder attached to the corresponding tool-head spindle. The thread is cut by employing a die-head on the tool-head spindle of position *D*. In position *E*, the piece is cut off by a tool mounted on the front tool-arm, but before this step is completed, the part is gripped in one of the collets of a transfer spider which carries the cut-off piece to a slotting attachment on the front of the machine for milling the slot to produce the fork.

Cutting a Small Gear in a Screw Machine

The most unusual of these examples is that shown at *G*, Figs. 1 and 3; this consists of a small pinion integral with a shaft. The pinion has thirteen teeth of 36 diametral pitch, which are cut by means of a special device mounted on the tool-head spindle of position *D*. The part is made from 7/16-inch diameter cold-drawn steel at the rate of one piece every twenty seconds. The work-spindles run at 840 revolutions per minute, which gives a surface speed of 100 feet per minute.

In position *A*, the cutter of a box-tool mounted in the holder of the tool-head spindle reduces the stock diameter, as illustrated in Fig. 3. In position *B*, the small-diameter end is turned to size by the cutter of another box-tool mounted on the corresponding tool-head spindle, and all other surfaces are finish-turned by a circular forming cutter mounted on the rear cross-slide. The shank end is rounded in position *C* by a pointing tool held in the tool-head spindle, and at the same time the large diameter of the shank is finished by a sizing forming cutter mounted on the rear tool-arm. This forming cutter is also provided with a roller that backs up the work during the cut.

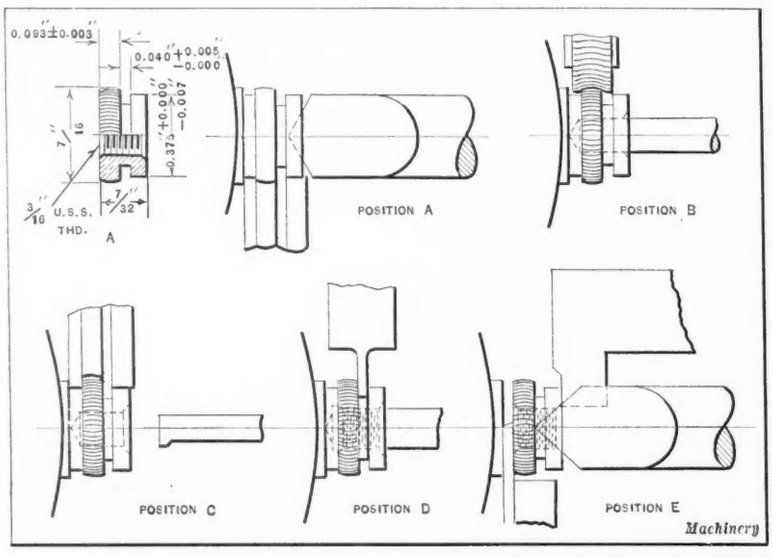


Fig. 5. Part manufactured in One Second, and Diagrams of Tools used

A hobbing attachment mounted on the tool-head spindle of position *D* cuts the teeth of the pinion. In this step, the work-spindle is stopped by the disengagement of a clutch, and held stationary. The tool-head spindle revolves and has a sliding movement to carry the hob to and from the work. The hob axis is in a plane nearly at right angles to the axis of the tool-head spindle, and correct for the angle of hob helix, and it is offset from the tool-spindle an amount to suit the diameter of the pinion. As the hob revolves about the axis of the tool-spindle, it revolves around the pinion, and by rotating on its own axis, cuts the pinion teeth. In position *E*, the small-diameter shank is knurled for a width of 1/4 inch by means of a tool held in the tool-head spindle and swung against the work by the front tool-arm. At the same time, a circular forming cutter on the front slide cuts off the finished part.

Two Larger Examples

At *H* in Figs. 1 and 4, is illustrated a part made from bronze tubing, 3/8 inch outside diameter and 0.197 inch inside diameter. Various forming, facing, and knurling cuts are taken at a production rate of one piece every five seconds. The work revolves at 1800 revolutions per minute, and in each position, with the exception of position *D*, a small-diameter rod in the tool-head spindle enters the projecting end of the work to support it during the cut. In position *A*, the part is knurled by rolls that are also attached to the tool-head spindle, and at the same time, a circular forming cutter on the front cross-slide forms the various surfaces on the left-hand end. In position *B*, a circular forming cutter on the rear cross-slide cuts the groove in the knurling on the right-hand end and cuts the burrs from this end.

A circular sizing cutter on the rear tool-arm advances on the stock in position *C*, to finish the different surfaces on the left-hand end. This cutter is provided with a roll that supports the front side of the stock during the cut. In position *D*, a 1/4-inch drill in the tool-head spindle drills into the hole of the tubing for a distance of 1/2 inch, and another cutter on the same tool-spindle, faces the projecting end of the work. Finally, a tool on the front tool-arm cuts off the piece in position *E*.

The steel piece shown at *J* in Figs. 1 and 4 is produced from solid stock at the rate of one piece every twelve seconds. In this example, the spindle revolves at 700 revolutions per minute, giving a surface speed of about 100 feet per minute. The tool-head spindle in position *A* is equipped with a combination stock-stop and center drill, so that a center is produced at the same time that the diameter of the entire piece is reduced by means of a circular forming cutter that is mounted on the front cross-slide. In position *B*, the piece is drilled for about one-half the length by a drill held in the corresponding tool-head spindle, and a circular forming cutter on the rear cross-slide produces two grooves and bevels both ends of the piece. Another drill, in the tool-head spindle corresponding to position *C*, completes the drilling of the axial hole while the different turned surfaces are being finish-sized by means of a circular forming cutter mounted on the rear tool-arm. During this step, the back of the work is supported by a roll mounted on the sizing tool-holder.

In position *D*, the axial hole is reamed to a diameter of between 0.2807 and 0.2812 inch by means of a reamer held in the tool-head spindle, while another tool attached to the same spindle takes a facing cut on the projecting end of the work. In position *E*, a collet on one of the fingers of a transfer spider slips over the projecting end of the piece while it is being cut off by a tool held on the front slide. Then, after the cutting off has been accomplished, this spider carries the part to the front of the machine in line with a milling cutter for producing the slot in the left-hand end, which is milled off center, as shown.

Part Produced in One Second

The brass part illustrated at *A* in Fig. 5 is produced from solid stock at the rate of one piece every second. Eleven distinct cuts are taken. The spindle speed is 1800 revolutions per minute, which gives a surface speed of about 200 feet per minute. In the tool-head spindle corresponding to position *A* of the machine in which this operation is performed, there is a combination stock-stop and centering tool, by means of which the stock is centered after it has been advanced the required amount. As soon as the work has been fed against the stop, a forming tool on the front cross-slide advances to turn the four circular surfaces. In position

B, the hole is drilled in the center of the piece by means of a drill held in the corresponding tool-head spindle, and at the same time, the rear arm swings a knurling tool forward against the largest portion of the piece.

After the work has been indexed into position *C*, the inner end of the hole is recessed by a cutter mounted in the tool-head spindle, the cutter being moved transversely the necessary amount after it has been fed longitudinally to depth. At the same time, a second forming cut is taken on the four circular surfaces by a tool mounted on the rear cross-slide. In position *D*, the piece is tapped by a tap mounted in the tool-head spindle, while the outer groove is finish-formed by a tool attached to the overhead cross-slide. Finally when the part has been indexed into position *E*, the outer end of the tapped hole is chamfered and the same end of the part faced by tools mounted in the corresponding tool-head spindle. At the same time, the part is cut off by a cutter mounted on the front tool-arm.

* * *

WIRE ROPE LUBRICATION

Engineers who have made a careful study of conveying equipment know how important it is to have wire rope or cable properly lubricated when it is used where materials such as ore, coke, or coal are handled. The extent to which neglect of this factor may affect the efficiency of a conveying system, however, is not well understood. In many cases, those in charge of such equipment have very little information available on the proper methods of applying the lubricant or the kind of lubricant best suited for the purpose. The following abstract from an article appearing in a recent number of *Lubrication*, published by the Texas Co., New York City, gives some interesting information on this subject.

The ultimate efficiency of material-handling equipment is, to a large extent, dependent upon the condition of the cables or wire ropes. A rope with one or two broken strands due to rusting or wear, traceable to improper lubrication, may not only cause a tie-up of the entire machine, if such strands interfere with the operation of sheaves or other companion cables, but may also present a distinct hazard. Any wire rope in such condition is just that much weaker and less capable of handling the imposed loads.

Visualize how important this might be in the case of a car unloading device, for example, where loads approximating 100 tons are frequently handled. It is not enough to assume that because such ropes come from the manufacturers in a lubricated state, being, in general, wound on an oil-saturated core, that further lubrication is unnecessary.

The Occurrence of Friction

There is constant friction and wear between the strands of wire rope while it is in use, and there is a tendency to squeeze out the lubricant, especially when the ropes pass over sheaves or around drums. The renewal of this lubricant is, therefore, an absolute necessity.

The matter of friction between the strands of a wire rope is essentially the same as friction between a bearing and shaft. Overheating and abnormal wear will practically always result in reducing the load-carrying capacity and increasing the amount of power consumed in operation. This can only be overcome by the proper application of a suitably prepared wire rope lubricating compound, which will not only be capable of penetrating to the innermost strands and core of the rope, but which will also be sufficiently adhesive and viscous to resist being prematurely squeezed out or washed off by rain.

Character of Wire Rope Lubricants

Essentially a wire rope lubricant, in addition to the properties mentioned, must not tend to cake, gum, or ball up, especially if contaminated with an excess of dust, dirt, or metallic particles. Furthermore, it must resist the thinning-down effects of higher temperature. This, of course, directly involves the viscosity or relative fluidity of the product. In fact, viscosity of such products is the essential characteristic involved in purchasing. It should not, however, be taken as the chief guide to the actual suitability of a wire rope lubricant.

In this regard, the ability of the latter to function, penetrate, and stick under actual operating conditions, is of outstanding importance. In consequence, such products should not be purchased haphazardly, nor on a price basis alone. The potential difficulties that might result are too serious.

According to the operating temperatures that may be involved, and the possibility of the presence of an excess of water, the viscosity of a wire rope lubricant should be 1000 seconds Saybolt at 210 degrees F., or somewhat lower. In warm climates, or when the ropes are adjacent to ovens, furnaces, etc., where there is danger of the lubricant becoming thinned down to such an extent that it will drip off, it is advisable to use a lubricant of about 1000 seconds viscosity at the temperature prevalent under operating conditions.

On the other hand, in relatively cold locations, such as are often found around lakes and in the northern countries, it is advisable to use a somewhat thinner lubricant selected in accordance with the range of the operating temperatures involved.

Wire rope lubricants should, in general, be straight mineral petroleum products, devoid of fillers or thickening mediums. In other words, whatever the viscosity, it should be an inherent property of the lubricant, not an artificial characteristic which cannot be depended upon.

It is for this reason that greases or soap-thickened mineral oils are relatively unsuited to wire rope lubrication. To attain the requisite body, a comparatively high percentage of soap would be necessary. Soap, of course, serves as the carrying medium for the oil. It has relatively no lubricating value, therefore, this property in the resultant product is decreased to a marked extent. Furthermore, the adhesive characteristic of greases is low. In consequence, such products will not, in general, meet the requirements of wire rope lubrication.

Application of Wire Rope Lubricants

As a general rule, wire rope lubricants, by virtue of their viscosity and inertness, must be applied in a heated condition. To merely attempt to daub or paint a rope with such a product at normal temperatures would be impracticable. Even though the surface might be more or less coated, the possibility of penetration occurring to any extent would be remote. We must realize that this latter is the secret of effective wire rope lubrication. The amount of wear occurring between the exterior of such a rope and the sheaves is not so marked as that which occurs between adjacent strands when the rope is flexed or bent, as in passing over sheaves, or hoisting drums.

The best method of treating wire ropes is, therefore, to use a form of split box for the lubricant which can be parted to permit it to be placed around the rope. The hole through which the rope passes is, of course, on the parting line. The lubricating box may be made from wood or metal. The shape of the box is determined somewhat by the angle or position of the rope. For horizontal ropes, a V-shaped box or trough with holes at each end near the bottom is generally used. Conical shaped boxes or containers are used for vertical ropes, the rope passing through a hole at the small end of the cone. Boxes of the kind described can be readily built in the average plant, with suitable provision for rendering it sufficiently tight to prevent the lubricant from leaking out even when reduced in viscosity by heating. The slow passage of the rope through such a bath of heated compound will not only insure thorough coating of the surface but also will cause the lubricant to penetrate to the inner strands. Further working of the rope over the sheaves before the lubricant has time to cool entirely will aid in bringing about maximum penetration.

* * *

The Cadillac Motor Car Co. recently completed its two hundred-thousandth automobile, equipped with a V-type, 90-degree eight-cylinder engine. The production of cars with this type of engine covers the last eleven years.

Current Editorial Comment

in the Machine-building and Kindred Industries

THE SPECIALIST'S TRAINING

When we speak of engineers and other technical men as specializing in a chosen branch of their profession, it is generally assumed that they have acquired a training in a limited field. This conception of the successful engineering specialist is usually erroneous. If he is to specialize successfully in any one type of equipment, a broad experience and training in the general engineering field is needed; because knowledge of the methods and practices of many branches of engineering are now required in designing the most specialized equipment. For example, an engineer who specializes in automatic refrigerators needs a good general knowledge of thermodynamics, refrigeration, chemistry and electricity.

The same is true in the strictly mechanical engineering field. The best planer designer is not the man who knows planers only. On the contrary, he is familiar not only with the design of various classes of machine tools and with the movements and mechanisms that have been and are applied to different machines in this field, but also with mechanical movements used in a wide range of machinery. The broader his mechanical knowledge is, the more successful a planer specialist will he be. If he knows nothing but planers, he will work in a narrow groove, and is likely to use over and over again the same ideas and methods of construction, without introducing any real improvements.

This is the age of specialists, but let us not forget that the ablest are those with the broadest general training, who apply their knowledge and stored up experience to a specific undertaking.

* * *

UNNECESSARY ACCURACY

Accuracy is the first engineering requirement, but carried to extremes may cause waste of time in engineering offices and drafting-rooms as well as in the shops. It is just as wasteful to spend labor on unnecessary refinements that serve no purpose as it is to spoil good material by careless and inaccurate work when the purpose in view requires extreme care and accuracy. Good judgment is necessary to determine the degree of accuracy that is required for different purposes.

Sometimes engineers and designers make calculations with extreme accuracy when absolutely accurate results either cannot be obtained, or, if obtainable, would be unnecessary for any practical requirement. Such accuracy may be a sign of careful work, but it is an indication of poor judgment.

Let us assume that a girder 48 feet 4 inches between supports is subjected to a maximum load of 20,000 pounds at the center; and that the stress in the girder must not exceed 12,000 pounds per square inch. Here the entire calculations are based on assumptions expressed in round numbers, and, therefore, it is not necessary to obtain the bending moment or the calculated stress with an accuracy that runs into decimals. Time is wasted in carrying out the calculations to such close figures. For all practical purposes, it is sufficiently accurate to express the bending moment in even thousands of foot-pounds and the maximum stress to the nearest hundred pounds per square inch.

Approximations like these, of course, are permissible only when the factors entering into the problem are based upon assumptions which themselves are likely to vary to a considerable degree. When we speak of the ultimate strength of a certain grade of steel as 60,000 pounds per square inch, it may actually be 59,700 pounds or 60,400 pounds, if subjected to a test in a testing machine; but we use round numbers in order to make practical calculations, and base them on known averages that have proved safe in the past.

There are many engineering calculations that require the most extreme accuracy, but that is when all the factors involved in the problem at the outset are definitely and accurately known. In that case no assumptions or approximations are permissible. What the engineer and the designer need most is ability to decide when extreme accuracy is required—the ability to distinguish between essentials and nonessentials. The possession of this faculty will save a vast amount of time.

* * *

TESTING LABORATORIES FOR TOOLS

More large industrial organizations, like the big electrical and automotive companies, would find it profitable to maintain testing laboratories for determining the quality of the tools and other equipment they use. In a few large plants this is done, but the practice is not general. In such testing laboratories the production of different types of tools and the results of different processes can be compared advantageously before they are put in actual practice.

If similar tools were offered by different manufacturers at different prices, it would be simple to determine by certain standard tests, whether the higher price would be warranted. Frequently it is. Our attention was recently called to a line of small tools offered at prices 15 per cent higher than competing tools, but which rendered about 50 per cent better service. The user has no means of knowing this in advance of actual use without testing their merits himself.

When comparisons are instituted between different methods or processes, as, for example, between milling and surface grinding, all the factors entering into the final result should be considered, such as the cost of cutters and grinding wheels, the time required for sharpening the cutters and dressing the wheels and the character of the surface finished by each process. By such studies the users of machine tools and small tools are able to form a definite idea of the relative value of different equipment. They are no longer dependent on mere opinion; they can base their decisions on facts.

* * *

WASTEFUL ALLOWANCES ON CASTINGS AND FORGINGS

There are two ways in which time and money may be wasted in machining operations—by using inefficient machines and methods that remove metal too slowly, and by leaving too much metal on castings and forgings to be removed in machining. Usually the waste caused by inefficient machines and methods is more evident than that caused by too great allowances in patterns and dies. To make sure that the castings and forgings will always "clean up," generous allowances are made; but it might be cheaper in the long run to have a part go through occasionally that will not "clean up," and that, therefore, will have to be scrapped, than continuously to remove perhaps twice as much metal as would be necessary if everyone were not constantly in fear of having a single casting scrapped.

One of the large electrical companies recently overhauled its patterns for the purpose of reducing the waste due to unnecessary machining, and found this detail a fruitful field for economy. Hard and fast rules cannot be laid down in this respect, but time is well spent in ascertaining that the allowances on patterns and forging dies are as small as consistent with minimum cost of machining.

Efficiency Methods in the Maxwell Plant

Operations on Driving Shafts, Bevel Gears, Axle Housings, Differential Cases, and Cylinders—Sherardizing—Testing Engines—Checking up Delays in the Assembly Line—By Charles O. Herb

NEW and improved methods of manufacture are constantly being developed in automobile plants to cut down production costs, to make parts more accurately, or to handle parts of new design. The efficient methods developed by this industry have often been successfully applied in shops building other products, and for this reason some of the operations performed at the Maxwell plant at Detroit, as described in the following, should be of interest to mechanical men generally.

Assembling and Welding Driving Shafts

The driving shaft of the Maxwell automobile is made up from a piece of steel tubing, 1 3/4 inches in diameter by 3/32 inch thick, and two spider forgings. The spiders have turned shanks that are driven into the reamed ends of the tube, and then welded in place on an automatic welding machine. Fig. 1 shows the machine used for driving the spider shanks into the tube. In this operation, the spiders are first mounted on plates *A* and *B*, which are provided with studs over which holes in the spiders are seated, the studs on the two plates being mismated. The tube is laid, as indicated at *C*, in a fixture provided with covers which are clamped down to hold the tube in alignment with the spiders. Plate *B* is attached to a standard air hammer *D*, held in a bearing at the right-hand end of the fixture. When the air is turned on, the piston of this hammer functions against the right-hand spider to drive it into the tube and the opposite end of the tube on the other spider. From the sound of the blows, the operator can tell when the job is completed.

As the operator removes the drive shaft from this assembling machine, he places it in the automatic welding machine illustrated in Fig. 2 for welding the shanks of the spiders so as to prevent them from turning in the tube or from coming out. Both ends of the drive shaft rest on driven rollers which, in turn, revolve the work. These rollers are driven by a small motor operated by a circuit breaker on the control panel. The motor is automatically started when an arc is established by the welding head which is located behind the hood at the right-hand end of the machine. At the same time a device is actuated that registers when one revolution of the drive shaft has been completed and opens a switch to shut off the current delivered to the welding head and the motor. The work is next reversed on the rolls for welding the opposite end of the tubing.

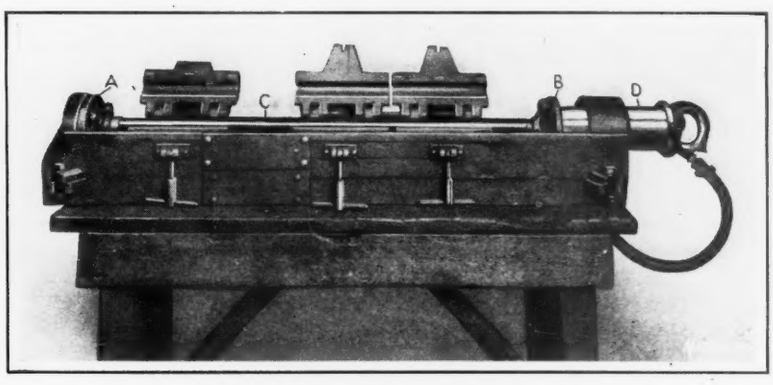


Fig. 1. Machine used for assembling the Spiders and Tubing which comprise the Drive Shaft of Maxwell Automobiles

These two machines have effected large savings, since they are tended by one operator and are quick-acting. With unskilled help, 750 welds or 375 completed drive shafts are turned out in nine hours, which is more than double the production obtained by hand-welding methods. The actual welding time per end is about thirty seconds, a welding current of 150 amperes and 1/8-inch electrode wire being used. After being welded, the drive shafts are tested for torque under certain load and angle conditions. It is said that while one tube in a thousand may break in this test, the break never occurs at the welds.

Boring and Facing Bevel Ring Gears and Facing Axle Housings

In boring and facing bevel ring gears in an automatic, special attachments are employed to feed two tool-slides transversely, at the same time that the boring-bar is fed longitudinally. One of these tool-slides is mounted on the front side of the carriage, as shown in Fig. 3, and the other on the rear. The tools rough and finish two straight and bevel surfaces on the face of the gear blanks. Boring-bar *A* is provided with three cutters, a rough-boring cutter, a finish-boring cutter, and a chamfering cutter. The front end of the bar serves as a pilot, and is guided by a bushing in the headstock.

Attached to the turret is a bracket *B* which is connected by link *C* to crank *D*. Through another link the crank is connected to tool-slide *E* at the front of the machine. When the turret advances, link *C* swivels crank *D*, which, in turn, pulls tool-slide *E* toward the work for the operation. An identical mechanism at the rear of the machine simultaneously advances the other tool-slide. When the boring-bar is withdrawn, the tool-slides also recede from the work. Rapid production in facing both sides of rear axle housings at the large central portion has been attained by means of the tooling equipment that is illustrated in Fig. 5. The cutter-head,

which is about 16 inches in diameter, is provided with seven inserted-blade cutters, and is guided by a pilot that enters a bushing at the center of the fixture. Plugs on the headstock and tailstock are fitted into the previously machined ends of the housing, and the housing is supported by adjustable pads that are raised into contact with the bottom by turning screws. Side thrust developed by the cutter is taken by screws that contact with the sides of the housing. In the operation, one side of the work is faced, and then it is reversed in the fixture for facing the opposite side. Coolant is used generously.

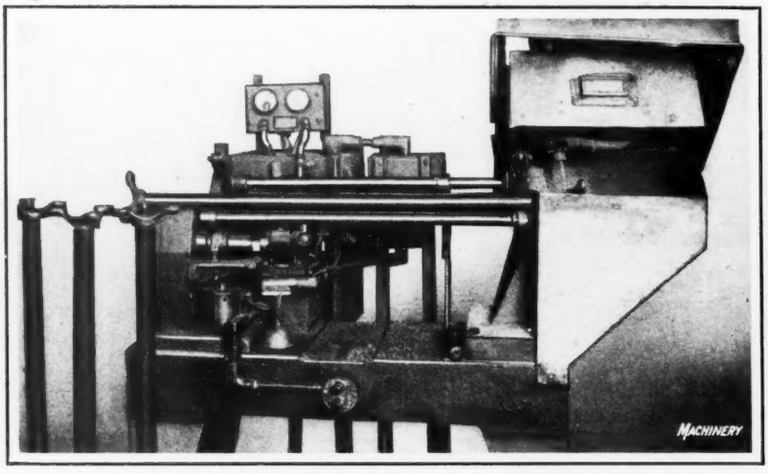


Fig. 2. Automatic Welding Machine used to weld the Two Spiders to the Ends of the Tubing

Various Operations on Differential Case Parts

In tooling up for handling part *A*, Fig. 4, of differential cases, considerable thought was necessary because of the odd shape of the part. The surface faced is of an oval outline, and to add to the difficulty of handling, there are two bearing lugs that interfere with the use of certain methods. For this operation, a two-station toolpost provided with roughing and finishing cutters is used. The cross-slide is moved transversely to suit the work by a cam mounted on a shaft that runs along the rear of the bed. A roller actuated by the cam transmits its movements to the cross-slide. The camshaft is driven by the headstock gearing.

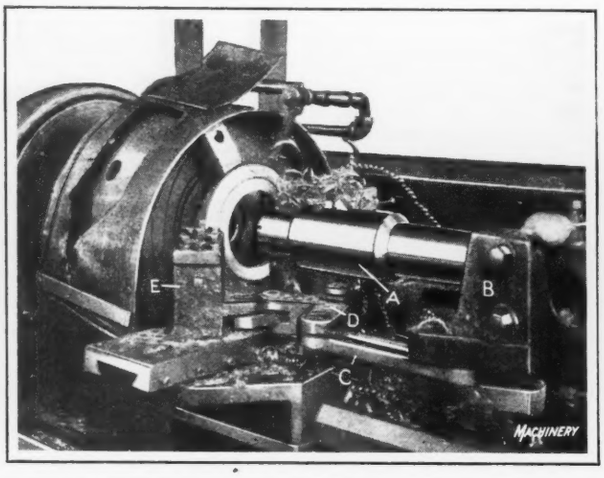


Fig. 3. Machining Straight and Bevel Surfaces of Ring Gears in an Automatic equipped with Special Attachments for feeding Two Tool-slides transversely

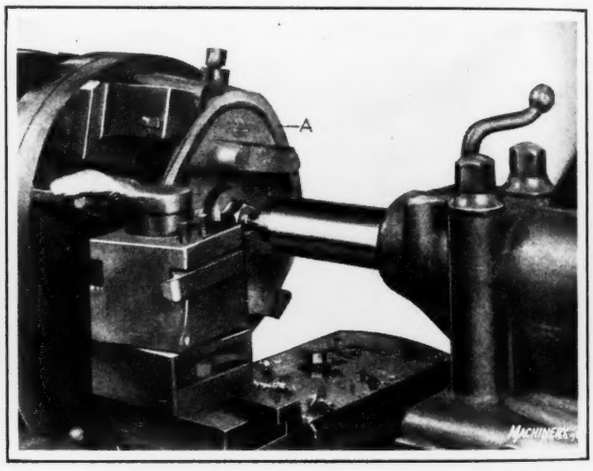


Fig. 4. Facing Operation in which the Cross-slide is actuated by a Cam mounted on a Shaft extending along the Rear of the Bed

Ten holes are drilled in the same part while it is held in the jig shown in Fig. 7. Minimum movement of the drill head is attained in this operation, because the jig is hinged on shaft *A* so that it can be swung 90 degrees downward to facilitate reloading the work. The part is seated on the jig and held in place by tightening a nut over a C-washer. Then the jig is swung up by simply turning crank *B*, and when it reaches the horizontal position it is automatically locked in place by a spring-actuated plunger. The plunger is withdrawn by handle *C* to permit dropping the jig at the end of an operation. Much time is saved because the drill head is raised and lowered only a slight amount more than is required for the actual drilling.

After the bearings of the differential carrier have been bored and reamed complete and threaded for a short distance in a battery of five vertical drilling machines, the bearings are finish-reamed or sized in the horizontal type of machine shown in Fig. 6. When the work has been seated in the jig, the boring-bar is inserted through the work and the reamers and connected to the spindle of the machine, the reamers being placed in positions *A* and *B*. The left-hand end of the boring-bar at *C* is 3 3/4 inches in diameter, and is threaded 16 threads per inch. After the job has been set up, handle *D* is locked to tighten half-nuts on this thread, and then when the machine is started, the revolution of the screw in the stationary nut causes the

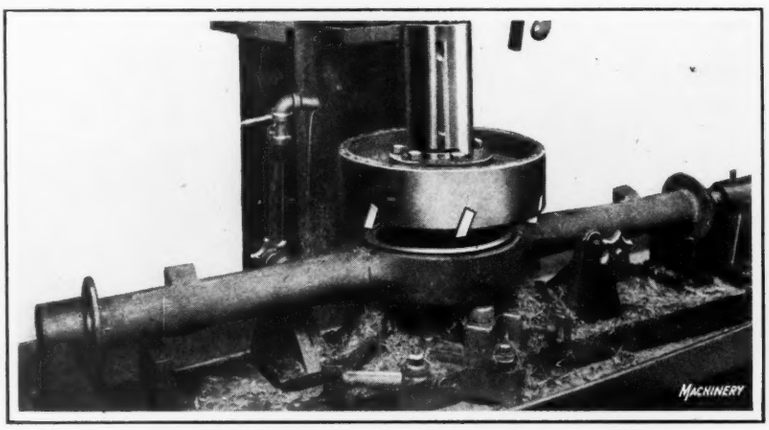


Fig. 5. Facing Both Sides of Rear Axle Housings at the Center with a Large 16-inch Head equipped with Seven Cutters

boring-bar to be pulled toward the left and reamers *A* and *B* to be fed through the bearings. At the end of the operation, handle *D* is raised, the boring-bar and reamer disconnected, and the boring-bar slid from the work and the reamers. The threads at one end of each bearing are cleaned out by running taps through them by hand.

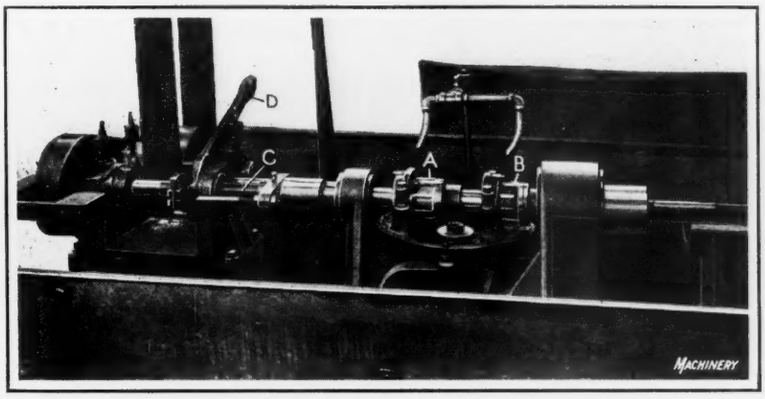


Fig. 6. Finish-reaming or sizing Two Bearings in One Half of the Differential Carrier

Cylinder Lapping Machine

Cylinder bores are lapped in different ways in various automobile plants. In some shops, only one bore is lapped at a time, but at the Maxwell plant all four are lapped simultaneously by using the machine illustrated in Fig. 8. This is an ordinary drilling machine arranged so that the head is fed up and down automatically to traverse four free-floating hones in the cylinder bores. The laps are run up and down a predetermined number of times, and then the bores are gaged to determine whether they are true within plus 0.002 or minus 0.000 inch, about 0.001 inch of stock being removed all around the cylinder walls in the lapping. Kerosene is supplied copiously to the hones from the tank shown to the left of the machine at the top.

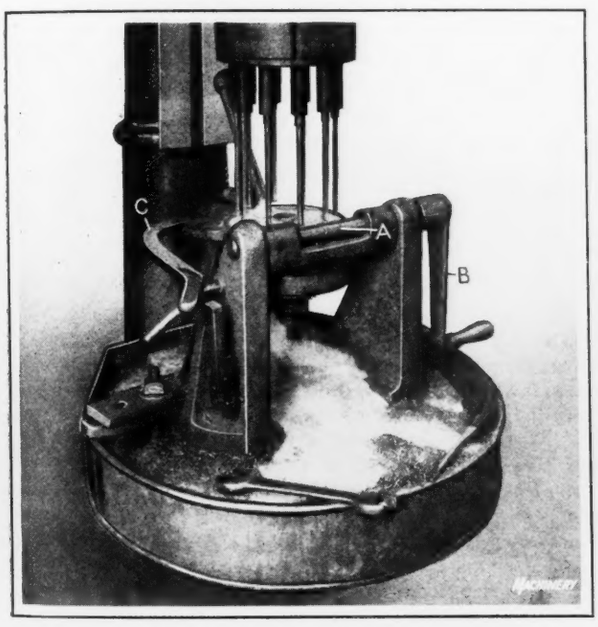


Fig. 7. Hinged Jig which saves Time in drilling Ten Holes in a Differential Case Part

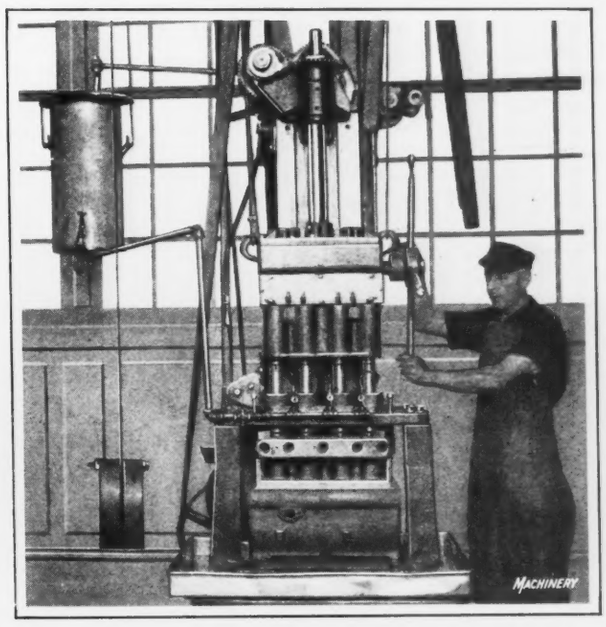


Fig. 8. Drilling Machine arranged for lapping All Four Bores of the Cylinder Casting at One Time

Sherardizing

There are many small parts on an automobile that should be rustproofed, and at the Maxwell plant this work is done in the sherardizing department (Fig. 9). Accelerator pedals, wind-shield bolts, crank-hole covers, four-wheel brake parts, etc., are subjected to this process. The parts are mixed with zinc dust in one of the two large drums seen in the illustration, and revolved from four to five hours in the furnace at a temperature of about 740 degrees F. At the end of that time, the drum is revolved for several hours on the stand shown at the left to cool the parts sufficiently so that they can be removed. This department can handle an average of 2500 pounds per nine-hour day per machine. The machine in the foreground, which is magnetic, keeps the iron content in the zinc dust down to a safe minimum.

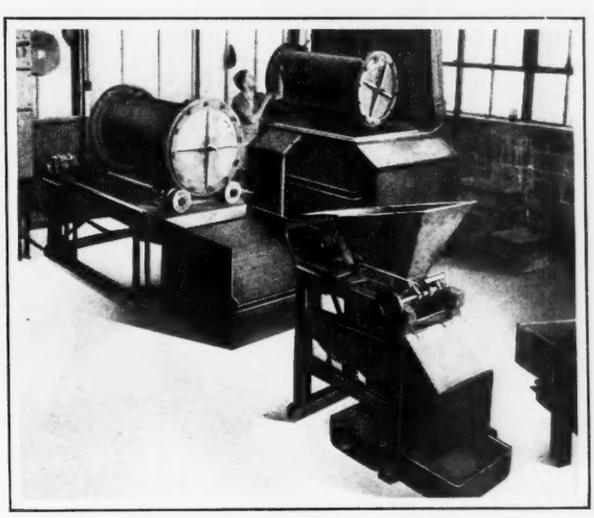


Fig. 9. Sherardizing Department where Large Quantities of Small Parts are rustproofed

Every engine built in this plant is subjected to a dynamometer test to see that they develop the required horsepower. The engines are also inspected while in the dynamometer test for timing, generator performance, carburetor setting, gear noise, tappet setting, etc. A general view of the dynamometer test room is shown in the heading illustration.

Checking up Assembly Tie-ups

Many tie-ups that occur in the assembly lines would be avoided if there were an easy means of making up a daily report to the shop executives that would give the names of the foremen responsible for each tie-up and the length of time that the conveyor was stopped. Such a means has

been installed at this plant, use being made of an International recording clock located in the superintendent's office. With this system, it is necessary to insert a key in one of a number of switches located along the conveyor, in order to stop or start the conveyor driving motor. The keys are in the possession of five foremen, and each key has a different character on it.

When a key is inserted in any of the switches, this character, the time of insertion, and the time of withdrawal are all recorded by the clock on a roll of paper. At the end of each day this roll is removed, and from it a report such as shown in the accompanying table is made out for the information of various officials. The reason for each stop is, of course, supplied by the man responsible for it. It will be observed that the report gives concisely all the information necessary, and the result of this system is that the foremen are anxious to have their name appear as seldom as possible on this report. On the day that this particular report covers, the entire idle time of the conveyor was only 39 minutes, whereas before the system was installed the total idle time sometimes amounted to 1 1/2 hours. All tie-ups along the assembly line cannot be blamed on the assemblers, however, as sometimes the manufacturing departments are slow in delivering materials or deliver defective materials; in such cases, these facts are brought out in the report and acted upon by the production department. Claude A. Bowlus, plant equipment engineer, devised this recording system and was in charge of the installation.

Report of Time Lost on Assembly Track and Causes for Same Date 4/9/25

Conveyor Stopped	In Dept.	Time Stopped	Time Started	Time Lost	Reason for Stopping Conveyor	Total Time Lost
Veronsi	79	7:09	7:11	2 Min.	Oper. behind in Body Assy.	
Jarvis	79	7:29	7:30	1 "	" " " Final "	
Veronsi	79	7:43	7:44	1 "	" " " Chassis "	
"	79	7:51	7:52	1 "	" " " " "	
"	79	8:56	8:59	3 "	" " " " "	
Roberts	77	9:18	9:21	3 "	" " " Frame "	
Veronsi	79	10:06	10:07	1 "	" " " Chassis "	
"	79	11:10	11:11	1 "	" " " " "	
"	79	11:26	11:27	1 "	" " " " "	
"	79	12:15	12:16	1 "	" " " " "	
"	79	12:26	12:27	1 "	" " " " "	
"	79	1:07	1:09	2 "	" " " Final "	
Jarvis	79	1:27	1:29	2 "	Truck off track at elevator	
Veronsi	79	1:49	1:50	1 "	Oper. behind in Chassis Assy.	
"	79	1:58	1:59	1 "	" " " " "	
"	79	2:15	2:16	1 "	" " " " "	
"	79	2:43	2:45	2 "	" " " " "	
"	79	3:09	3:11	2 "	" " " " "	
"	79	3:14	3:14	0 "	.. ..	
Roberts	77	3:27	3:31	4 "	Air Motor broken in Frame Assy.	
Veronsi	79	3:37	3:38	1 "	Oper. behind in Chassis Assy.	
"	79	4:06	4:08	2 "	" " " " "	
Jarvis	79	4:15	4:17	2 "	" " " Final "	
Roberts	77	4:42	4:45	3 "	Held up by Plt. 1 for motors	39 Min

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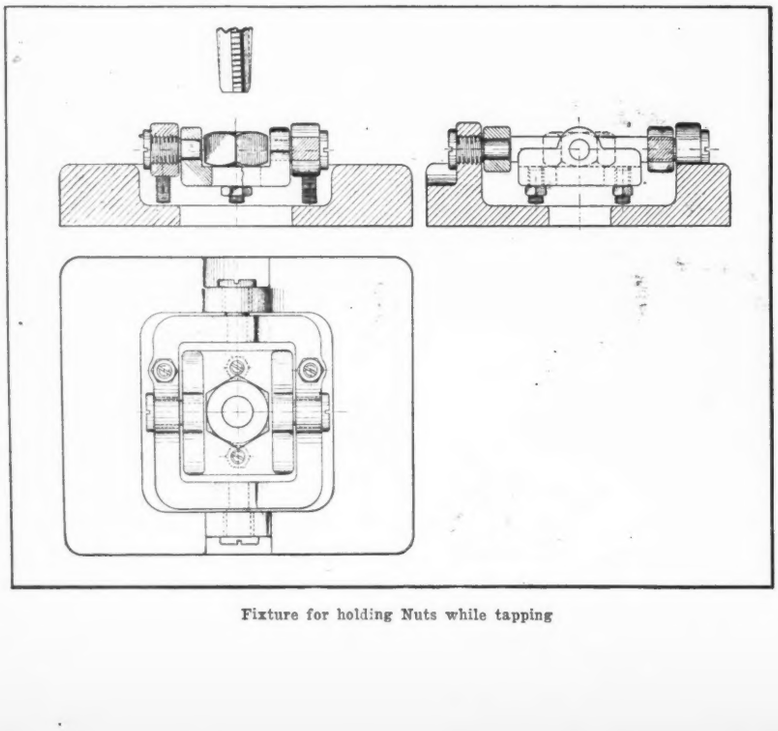
NUT THREADING FIXTURE

Better threading can be done when threading nuts if the nut is held in a holder that permits it to float. The holder shown in the illustration consists of a kind of double cradle, one cradle being mounted in the baseplate and the other mounted in the first with its axis at right angles to the axis of the first cradle. Two adjusting screws are provided for each cradle to limit the amount that they rock when the fixture is in operation. Furthermore, the nut does not fit tightly in the holder, but has a certain amount of freedom or clearance, so that it is able to adjust itself readily to the tap.



Fixture for holding Nuts while tapping

* * *

MACHINE TOOLS IN BRAZIL

In an article in *Commerce Reports*, by assistant trade commissioner, M. A. Cremer, of Rio de Janeiro, Brazil, attention is called to the fact that the competition offered by Germany in the sale of light machine tools in Brazil is very active. England, France, and Denmark are also competitors in this field, but not on the same scale. When it comes to heavy machine tools, those of American manufacture meet with little competition. The prices of light machine tools coming from Germany, although rising, are still much less than the prices of similar equipment imported from other countries. In addition, German manufacturers have consigned the machines to importers who, in turn, grant credit to their customers. The terms of credit have run for as long as fifteen months to two years. During this time, however, the machinery remains the property of the importer.

The predominance of light German machine tools is explained by the fact that the Germans were well established here before the outbreak of the war, and their product was well known in this market. It is difficult to say what German prices will be on machines that actually must be ordered from Germany at the present time, because most of the sales at the moment are made from stock that has been on hand for some time.

* * *

WIDE PROVINCE OF THE ENGINEER

Since in the exercise of his functions as an engineer he must, of necessity, develop and employ habits of mind and methods of study which may be usefully employed in dealing with problems as they arise in all activities of life, therefore should the engineer stand ready to serve, not only in his chosen sphere, but wherever and whenever his habit of mind, his training, and his experience may enable him to contribute a helpful element in this great cooperative enterprise which we call civilization.—*W. F. Durand, Past President, A. S. M. E.*

Notes and Comment on Engineering Topics

The first Italian subway was opened in Naples, Italy, on September 20, according to *Commerce Reports*. It is stated that the subway trains cover in thirty-five minutes the same distance that an ordinary street car covers in 1 1/2 hours.

To keep pace with the demands of the electrical industry, the Bureau of Standards is extending its facilities to measure potentials as high as 350,000 volts—an undreamed of voltage only a few years ago. Long-distance transmission power projects are now planning the use of very high voltages, and so it has become necessary for the bureau to equip itself for tests in the new voltage range.

According to an article in *Naturwissenschaften*, investigations made by a Japanese physicist, H. Nagaoka, lead to the conclusion that the mercury atom may be disrupted in an electric field of exceedingly high intensity, and that after the discharge has taken place, unmistakable traces of gold will be found. It has long been believed by many scientists that if means were found to disrupt the atoms, it might be possible to change one chemical element into another.

The Bureau of Standards, during its last fiscal year, completed 171,196 tests, an increase of 26 per cent over the preceding year. The character and scope of these tests spanned the province of applied science from sugar to cement, from clinical thermometers and other precision instruments to motor oils and brake linings, from industrial photography to studies in model housing and home financing. During the year, the total fee value of all tests was $544,384, an increase of $34,500 over the corresponding figure for last year.

The rapidly growing motor vehicle market abroad is indicated by the fact that the annual export business now exceeds one-half million cars, or about one-eighth of the production schedule. This gain in foreign markets, added to domestic business, has created a demand which made the year 1925 pass the four-million mark for the second time in the history of the automobile industry, the total exceeding 4,200,000 vehicles. The improved economic conditions in Europe and road development in all parts of the world are resulting in greater demand for motor transportation.

In the annual report of the Department of Commerce, reference is made to the remarkable improvement in railroad transportation during the last two years. The periodic car shortages of many years have practically disappeared, although the tonnage loaded has increased more than 25 per cent since 1921. There has also been a great increase in the efficiency of railroad operation since 1921. Average weekly car loadings have increased from less than 700,000 to nearly 1,000,000, the number of miles per car a day from 22.4 to 26.9, and the average train load from 656 to 731 tons.

The total output of electricity by public utility power plants in the United States from January to September, 1925, inclusive, was 47,570,000,000 kilowatt-hours—an increase of 10 per cent over the same period in 1924. The output by the use of water power for the same months was 16,548,000,000 kilowatt-hours, which also represented an increase of 10 per cent over the same period for 1924. The total capacity of generators in electric public utility power plants in January, 1924, was 19,400,000 kilowatts. In February, 1925, the total capacity was 22,500,000 kilowatts—an increase of over 3,000,000 kilowatts, or about 16 per cent in the thirteen-month period.

An interesting device for facilitating the work of marking or painting white lines on automobile roads, known as the A. B. C. traffic line marker, has been brought out by the Highway Appliance Co., Providence, R. I. This machine is designed to be operated by either one or two men—one man for straight line work, such as cross-walks, parking zones, etc., and two men for curved lines, where it is important that the machine be carefully guided. It is stated that the machine will cover twenty times the distance in one hour that could be marked if the work were done by hand. This is another indication of the efficiency of the machine over a man unaided by mechanical means.

It is stated that of the number of students entering the engineering schools of the country, only 40 per cent graduate. One of the reasons for this is that a great many students select engineering as a career when they are not fitted for engineering studies. It is also generally admitted that of all the courses offered by universities and colleges, the engineering courses are the most exacting and require not only the most thorough preparation before entering college, but also the most intensive application during the college course. Many students taking these courses do not have an adequate idea of the requirements that will be placed upon them and are not equal to these requirements, either in mental capacity or in stamina and character development.

Engineering has been one of the last fields in industry to be invaded by women. In the civil engineering field particularly, men have held the monopoly. It is of interest, therefore, to note that Miss Helen Grimshaw has been enrolled in the Institution of Civil Engineers of Great Britain—the first woman admitted since the founding of the institution in 1818. She is the daughter of Conway O. Grimshaw, for twenty-five years a member of the institution, who, in turn, is a cousin of Dr. Robert Grimshaw, for many years a contributor to MACHINERY'S columns. C. O. Grimshaw was at one time a draftsman with the Brown & Sharpe Mfg. Co., and is at present engineer for the Westminster Electric Supply Co., the largest lighting and power plant in Great Britain.

Some interesting developments in the application of Diesel engines to locomotives were referred to in a paper contributed recently to *Mechanical Engineering* by the Oil and Gas Power Division of the American Society of Mechanical Engineers. Among the various developments mentioned were two 1200-horsepower Diesel locomotives built in Germany. Each of these locomotives is equipped with a six-cylinder, 450 R.P.M. Diesel engine weighing 29 tons. One of the locomotives has electric transmission, and the other has gear transmission. The total weight of the electric transmission locomotive is 137 tons, or 230 pounds per horsepower. Another interesting type of Diesel locomotive uses the Diesel engine to drive an air compressor. The compressed air is heated by the exhaust gas from the engine, and then develops power in the ordinary type of locomotive cylinders. It is expected that this locomotive will develop, at the wheels, 27 per cent of the power represented by the heat value of the fuel.

BLOCK INDEXING

With the multiple or "block" system of indexing, which is sometimes used in gear-cutting, a number of teeth are indexed at one time instead of cutting the teeth consecutively, and the gear is revolved several times before the teeth are all finished. For example, when cutting a gear having twenty-five teeth, the indexing mechanism is geared to index four teeth at once, and, the first time around, six widely separated tooth spaces are cut. The second time around, the cutter is one tooth behind the spaces previously milled. On the third indexing, the cutter has dropped back another tooth, and the gear is finished (in this case) by indexing it around four times. The object of this method is to distribute the heat generated by the cutter (especially when cutting cast-iron gears of coarse pitch) more evenly about the rim of the gear, thus avoiding distortion due to local heating, and permitting higher speeds and feeds.

INSULATION FOR ELECTRICAL WORK

Insulating materials form a very important part of electrical apparatus, and, in fact, the size and design of most electrical machinery is largely dependent upon the insulation. The conductors employed in the electrical industry are few in number. Copper and iron meet most of the requirements and, in various forms (wire, strips, sheets, bars, blocks, and castings), successfully serve the manifold purposes to which conducting elements are applied. Insulating materials, on the other hand, comprise a large number of substances, varying widely in composition and physical properties. In some instances, materials are required which are highly heat-resistant or arc-proof, as finger shields or arc deflectors in controllers, heating device insulation, etc., whereas in other cases the insulating material must become liquid or soft, or self-healing under heating or arcing, as in high-tension bushings. A definite amount of wear under abrasion is required in certain construction, as in commutators and magneto distributors, but in other cases, there must be a minimum of abrasive wear, as in rheostat dead segments, wire insulation, etc. Heat conductivity is an important requirement in some instances, as in armature coils, but in other insulation, as in heating devices, a minimum heat conductivity gives greatest efficiency. It is obvious, therefore, that in insulating work diametrically opposite properties are often required in the materials used. It is because of the necessity of meeting these varied requirements that the large number of insulating materials now employed in the electrical industry have been developed.

DIAMAGNETISM

Materials, like iron and steel, that are attracted by the poles of a magnet, are known as "magnetic"; those that are not attracted by a magnet are generally known as "non-magnetic." It has been shown, however, that practically all substances are acted upon in some manner by a sufficiently strong magnetic pole, but only a comparatively small number are attracted like iron, while the great majority of materials are repelled. Those substances that are repelled by the magnetic pole have been termed "diamagnetic." The strongest of all diamagnetic metals is bismuth; that is, of all substances this metal is repelled by a magnetic pole more than any other. Its diamagnetic qualities are so pronounced, in fact, that they can be detected by means of any good permanent magnet. Of the metals, gold, silver, copper, lead, zinc, antimony, mercury, and bismuth are all diamagnetic, while tin, aluminum, and platinum are attracted by a very strong magnetic pole.

LOADED GRINDING WHEEL

A grinding wheel is "loaded" when the pores or interstices between the cutting particles are partly or entirely clogged with the material being ground. Loading prevents the wheel from cutting and causes excessive heat to be generated. If a wheel becomes loaded, the bond may be too hard or the speed too slow. The remedy for loading is to increase the speed or use a softer wheel.

WIRE ROPE TRANSMISSION

The application of wire rope for the purpose of transmitting power was first made in 1850, in Switzerland. With this system of transmission, an endless wire rope is employed which runs over large sheaves, the grooves of which are usually filled with rubber or wood. Ordinarily, the sheaves are of cast iron and are made as light as possible. In addition to the rubber and wood fillers, various other materials have been used for filling the grooves, such as tarred oakum, jute yarn, and leather. With rubber and leather fillings, considerably more power can be transmitted than when using wood-filled sheaves. As a general rule, this system of transmission should not be used for shorter center-to-center distances than 50 feet, and it may be employed without supporting idler sheaves, for distances up to 300 feet. For greater distances, guide sheaves should be used at points 300 feet apart or less. Double-groove sheaves are also used in some cases; these are spaced 300 feet apart and serve to divide the transmission system or rope into a number of independent sections.

SOLDER

Solder is almost always composed of an alloy of two or more metals. The solder used should have a lower melting point than the metals to be joined by it, but the fusing point of the solder should approach as nearly as possible to that of the metals to be joined so that a more tenacious junction is effected. Soft solder consist chiefly of lead and tin, although other metals are occasionally added to lower the melting point. The fusibility of lead-tin alloys increases with the percentage of tin up to a certain point, but when the tin exceeds 67 per cent, the melting point rises gradually to the melting point of tin. Soft solders are termed common, medium, and fine, according to the tin content, those containing the most lead being the cheapest and having the highest melting points. Fine or "best" solder is largely used for soldering Britannia metal, brass, and tin-plate articles. The soft solder called "common" is used by plumbers for ordinary work, this solder containing two parts of lead to one part of tin. Fine solder is also used for soldering cast iron, steel, copper, and many alloys. Solder composed of two parts of lead and one part of tin is termed, in England, "plumbers' sealed solder." Hard solders for brazing are composed of copper and zinc, the composition varying according to the metal to be brazed.

HYGROMETER

The hygrometer is an instrument for measuring the absolute or relative amount of moisture or humidity in the atmosphere. When the instrument is used only to determine changes in the humidity, it is termed a "hygroscope." The instrument depends usually upon the contraction or extension of certain substances when exposed to varying degrees of moisture. The contraction of a substance with an increase in humidity, for example, can be recorded on a scale, and thus indicate the relative amount of moisture in the atmosphere.

MACHINERY'S SCRAP-BOOK. February, 1926

FRICTION GEARING

The term "friction gearing" is commonly applied to that type of gearing consisting of a driver made of some substance such as fiber or leather and arranged to operate by rolling in contact with a metallic driven wheel. The driving and driven wheels may be either cylindrical for driving parallel shafts or conical for driving shafts at an angle; when speed variations are required a small driving disk may be arranged to revolve in contact with the side of a comparatively large driven disk, which also provides for reversing the rotation merely by shifting the driver to the opposite side of its central position on the driven disk. With the latter arrangement the axes of the driving and driven members are at right angles, and pure rolling contact is not obtained when using a driver of cylindrical form, since it makes contact with the driven disk at various diameters. Friction gearing provides a smooth, uniform drive, but toothed gearing is superior for most purposes because of its positive action and greater power-transmitting capacity. The latter may also be designed to transmit much more power, and at the same time insures maintaining the same relative positions between the driving and driven members, which is important for many classes of mechanism.

ENGINE INDICATOR

A diagram may be made to represent graphically the work done in a steam engine cylinder during one stroke of the piston. An indicator is a device for making a diagram of what actually takes place in an engine cylinder under working conditions. Such a diagram shows the points of admission, cut-off, and release, and indicates accurately the pressures acting on both sides of the piston at all points of the stroke. The indicator diagram gives a means of determining the mean effective pressure, from which the indicated horsepower of the engine can be determined.

BUCKET CONVEYORS

Bucket conveyors consist of a series of equally spaced buckets attached either to a belt or a chain. Grain conveyors are always encased in wooden and steel casings, and the casings are nearly always vertical. The usual support for the buckets in this case is belting—either leather, cotton, or rubber. For coal, coke, and other heavy materials, the buckets are fastened to chain links, either single or double strand, depending upon the capacity for which the conveyor is designed; and, in this case, the conveyor casing is usually carried in a slanting position. Conveyors in a vertical position are only suitable for specifically light material and can be run at a circumferential velocity of from 250 to 350 feet per minute. Conveyors for heavy material must be wholly or partially inclined to give a clean delivery without scattering, and they should run at a speed of from 50 to 160 feet per minute. Bucket conveyors should always be driven from the top so that the upward side of the conveyor (the side containing the load) can be tight, while the empty side will run slack. A bucket elevator may be defined as a vertical bucket conveyor.

HENRY

The henry is the unit of electrical induction, and is equal to the induction in a circuit when the electromotive force induced in this circuit is one volt, while the inducing current varies at the rate of one ampere per second. The one volt induced does not include the electromotive force necessary to overcome the resistance of the circuit. A millihenry is one-thousandth of a henry.

GRANITE

Granite is one of the rocks or stones consisting principally of quartz and felspar, which is valuable as a building material, as a material for foundations, etc. The general properties of granite may be specified as follows: The weight of granite per cubic foot is 170 pounds; the specific gravity averages about 2.72; the compressive strength per square inch is about 15,000 pounds; the shearing strength per square inch is about 2000 pounds; the tensile strength per square inch is about 1500 pounds; the modulus of elasticity is about 7,000,000; and the coefficient of linear expansion due to heat, for each degree F., is 0.000004.

PIPE MADE BY LAP-WELDING

The larger sizes of pipe for high-pressure purposes are made by a process whereby the edges of the plate are overlapped at the seam instead of being abutted. This is called the lap-weld process. The plates are suitably rolled, and the longitudinal edges are slightly beveled where they are to overlap, in order to avoid undue thickness at the welded seam. They are then heated and bent into rough tubular form, with the edges overlapping, either by means of rolls, such as those use in bending boiler plate, or a bending die especially designed for the purpose. Thus bent, the rough tubes, or skelp, as they are called, are charged into the rear of a furnace, where they are heated to a welding temperature. After reaching this temperature, they are pushed out of an opening in the front of the furnace until caught by the revolving rolls of the welding apparatus situated a few feet from the opening. These rolls are so grooved that they form a circular opening between them of approximately the same size as the outside diameter of the pipe, and in this opening is a bullet-shaped mandrel, held on the end of a strong steel rod. As the pipe skelp comes from the furnace it is caught by the rolls which force it forward over the mandrel, and thus press the overlapping edges together into a sound weld.

SPIEGELEISEN

Spiegeleisen, a German term adopted for an alloy of manganese and iron, contains about 12 per cent of manganese and 4 per cent of carbon, with the remainder iron. The term "spiegeleisen" means "mirror iron," this name being given to the alloy on account of the brilliancy of its fracture. Spiegeleisen is used in the Bessemer process of making steel, for recarburizing the molten charge in the Bessemer converter. The spiegeleisen is added in a molten state.

HYDROGEN

Hydrogen is a gaseous chemical element, the symbol of which is H, and the atomic weight, 1.008. The specific gravity, as compared with air, is 0.0694. Its specific heat equals 3.40. It becomes fluid at a temperature of —252 degrees C. (—421 degrees F.), and solidifies at a temperature of —258 degrees C. (—432 degrees F.). Hydrogen is one of the chemical constituents of water, oxygen being the other constituent. Hydrogen burns with a pale blue non-luminous flame at high heat, the oxy-hydrogen flame being used in autogenous welding and in flame-cutting processes. With air or oxygen, hydrogen forms a highly explosive mixture, especially in the proportion of two volumes of hydrogen to one volume of oxygen. It is, therefore, important to take care that free hydrogen does not mix mechanically with air or with free oxygen. Hydrogen is produced commercially as a by-product in the production of oxygen by the electrolytic method.

What MACHINERY'S Readers Think

on Subjects of General Interest in the Mechanical Field

OVERWORKED FOREMEN

In many factories, especially in the small and medium-sized ones, the duties of the foremen cover a large field, such as hiring new men and putting them to work, recording their time, inspecting their work, instructing the men in regard to each new job, ordering material, and setting rates, in addition to many other duties. The result is that these men are often overworked and cannot give the attention to their job as supervisors of the department. The man in charge of a shop should see that the foremen are not loaded down with a great deal of detail work that could be done just as easily by a clerk or an office boy. It is false economy to use high-priced foremen in a clerical capacity, even though it appears to save a clerk's wages. The foreman's time could be more effectively used in devising methods for increasing the quantity and improving the quality of the work in his department. C.

* * *

TECHNICAL WRITING

Having read with great interest the article entitled "Technical Writing" in October MACHINERY, the writer desires to add a few more notes on the art of technical writing. As stated in the article referred to, it is undoubtedly true that in practically every branch of mechanical engineering there are men who possess specialized knowledge of equipment and methods which has never found its way into print. It is of the greatest importance that those who have such knowledge should make an effort to place it on permanent record, so that it may be available to others.

Unfortunately, the literary side of mechanical engineering is one that appears to be strangely neglected by many men whose practical experience would enable them to contribute very easily to technical journals, with advantage to both themselves and the engineering world generally. Apart altogether from the pecuniary benefits derived, the mere act of expressing knowledge in a clear and orderly manner is a valuable means of retaining acquired knowledge in a way which, for efficiency and ease, is unapproachable by any other system of memory training.

Novices should not be daunted at the outset by fears that grammatical errors, or mistakes in construction or style, will cause an editor to reject their manuscripts. As a matter of fact, many ideas that have made fortunes would never have been heard of had their inventors been dependent upon the ability to express themselves well. Ideas dealing with the difficulties and problems arising daily in engineering and industrial establishments are mostly wanted, and, in fact, every hint or suggestion, founded on practical experience, or prompted by the latter, will always be gladly received, no matter to what branch of engineering it refers, or by what humble worker it is sent.

Technical writers should do their utmost to explain simple points, particularly if their craft is a special one and its methods not generally known to the majority of readers. If a device for performing certain work is to be described, the writer should describe the work to be done before enlarging on the details of the device. Never attempt to bring in matter extraneous to the subject treated in the article. Tell all there is to be told about the subject treated, and then, if there is something to be told about some other subject, write another article. Generally speaking, technical writers are men who have worked in several manufacturing and industrial establishments, such as toolmakers, machinists, draftsmen, demonstrators, foremen, etc. Thus, having had access to a large number of manufacturing operations, their minds are well stored with practical knowledge concerning methods and equipment.

In conclusion, men who record their knowledge and transmit it by publication to thousands of readers become members of that class to which is largely due the advancement of industrial knowledge. E. DARWELL

* * *

GIVE THE AFTERCOOLER A CHANCE

On page 300 of December MACHINERY are given some interesting figures concerning the results obtained from the operation of a compressed-air aftercooler. The free air compressed per month—175,000,000 cubic feet—would, in the mass, form a cube having a base covering a little over 7 acres and a height of 560 feet. Assuming a mean atmospheric temperature of 60 degrees, the weight of the moisture contained in the air at the point of saturation, or 100 per cent humidity, would be 5.74 grains per cubic foot. If we assume in this case a humidity of 50 per cent (and in a "dry" atmosphere 900 feet above sea level it is probably not less than that), the weight of moisture per cubic foot would be 2.87 grains. The total weight of the moisture in the 175,000,000 cubic feet of air would be 71,750 pounds avoirdupois. In the article referred to it was stated that the aftercooler collected 3750 gallons, or 30,000 pounds of water, figuring 8 pounds to the gallon.

A simple computation shows that more than 41 per cent of the water originally contained in the air was thus captured —a gratifying result, but not all that it should have been possible to trap. It certainly gives some idea of what an aftercooler can do when it gets the opportunity. The fact that water was still collectable in pockets along the line shows that the air was not so very dry after all. As the air was compressed from one atmosphere to three atmospheres, its volume, when restored to normal temperature, was only one-third of the original, so that to leave the air only as moist as it was before the compression began, 66 per cent of the moisture should have been removed. The writer does not assert that this could have been done in the case referred to, but it would be well to keep these comparisons in mind.

When the air is compressed to a higher pressure than in this case, say to 7 or 8 atmospheres, which is quite common in operating rock drills or pneumatic tools, it is possible to extract more of the water. It should always be remembered, however, that the function of the aftercooler is not to extract the moisture but, as its name implies, to cool the air. This incidentally puts the air into a condition beyond saturation, where a portion of the moisture content must cease to be vapor and becomes actual water, but still remains in the air, distributed all through it in minute globules.

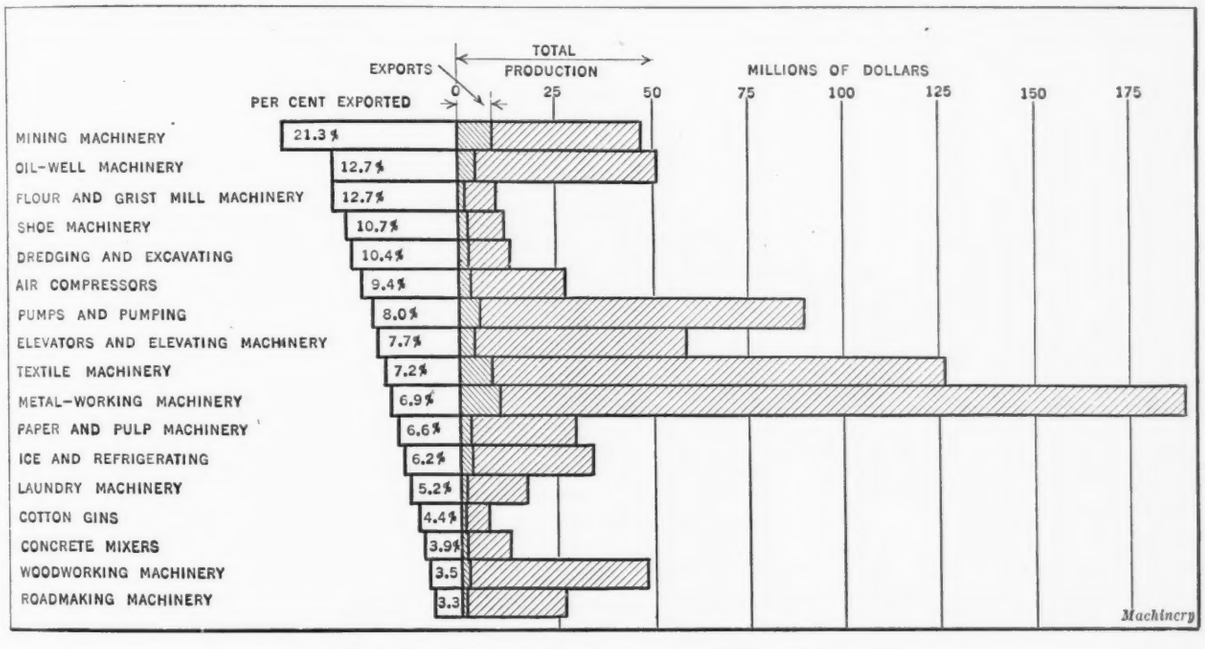
The water in this state wets and clings to whatever it touches, and in this way it collects and drips or runs off from the interior surfaces of the aftercooler. Thus the separation of the water begins while the cooling is going on, and much water can be drawn off from the aftercooler, but the cooling is not completed and much of the moisture is not brought into the "ready-to-leave" condition until the cooling is finished and the air is actually leaving the aftercooler. Here is the time and place for the final separation of the water, when the air pressure is at its highest and the temperature at the lowest point. The separator should then be ready to take care of it. FRANK RICHARDS

WHAT IS YOUR EXPORT RATIO?

The importance of developing export trade is pointed out in an article in *Commerce Reports* by W. H. Rastall, chief of the Industrial Machinery Division of the Bureau of Foreign and Domestic Commerce. Certain lines of machinery are exported in larger quantities than others, and the question arises as to what factors govern the volume of trade.

Why should manufacturers of air compressors have a better export business than manufacturers of concrete mixers? At first thought, one might expect the advantage to lie with the concrete-mixer manufacturer because of the nature of the work and the surroundings under which his product is commonly employed. Why should the percentage of export orders secured by a manufacturer of excavating machinery be greater than that of a manufacturer of metal-working machinery? American excavating machinery usually represents a high state of engineering development. These units are frequently very costly, and one might expect that the labor conditions in most foreign countries would make it unnecessary to employ machinery of this character, while machine tools are necessary for a great number of manufacturing operations and would seem to be in more general demand.

The accompanying chart indicates the total volume of production and the percentage exported applying to certain classes of American industrial machinery, and it is interesting to speculate whether the situation illustrated by this diagram is the result of fundamental conditions or merely expresses the comparative business ability and sales effort manifested by the management of these different producers of machinery.



Production and Exports of Certain Classes of Industrial Machinery in 1925

Unusual Foreign Trade Opportunities Open to Americans

Conditions have now reached a point where American machinery manufacturers should give careful attention to their export business. Unusual opportunities are to be found in these foreign fields because Germany is gradually losing its position as a competitor. Before the war Germany furnished perhaps 45 per cent of the machinery that went into international trade, and since the war there have been times when the depreciated condition of the mark gave German manufacturers a peculiar advantage in this trade. That situation has now passed, and in great measure German prices already exceed world-market levels. Experience shows that deliveries from German manufacturers are slow and frequently uncertain, and in a great many ways it is difficult for foreign dealers to buy in Germany on a basis that is at all satisfactory. Trade that formerly went to Germany will more and more fall into the hands of others.

Although there are a number of countries in the world that produce machinery for export, the countries of outstanding importance at present are Great Britain and the United States, and the indications are that the large volume of machinery business formerly secured by German manufacturers will now be awarded to either British or American producers.

Quality Should be the Basis of American Sales Efforts

American engineering and American machinery are distinguished in the world's markets for their superiority. Americans are noted for their engineering achievements, but, because of this superiority, American machinery is usually higher in price than similar equipment secured from foreign sources, and must be marketed on a quality rather than a price basis. In other words, this trade, which formerly went to Germany, will now pass to British manufacturers unless American products are supported by constructive sales effort of such character as to demonstrate that American equipment is worth the price asked, and more. Manufacturers should now organize their sales effort along such lines as will accomplish this result.

Satisfactory Export Ratio Essential

Export business is becoming more and more essential to the prosperity of the individual manufacturer. The accompanying chart shows that it is of great importance to manufacturers of mining machinery. The difference between a satisfactory or an unsatisfactory export ratio can easily represent the difference between profit and loss on the year's balance sheet. Manufacturers have a definite opportunity to improve their export ratio, and it remains for them to make the sales effort necessary to secure these results. The present international situation provides an unusual opportunity.

* * *

Fifty makes of cars were on display in the Grand Central Palace, New York City, during the week January 9 to 16, at the National Automobile Show, and about the same number will be shown at the Coliseum in Chicago, January 30 to February 6. In addition, there will be eight makes of taxicabs exhibited. At the New York show, 156 accessory and parts manufacturers exhibited.

Fuel Oil System for Forge Shop

By C. C. HERMANN, President, Hermann Associates, Inc., Engineers, Rock Island, Ill.

FORGING furnaces are generally installed at such points in the forge shop as will facilitate routing the work in the most direct or convenient manner. As the oil supply lines can be run to any part of the plant, they are given very little consideration when the furnaces are located. Unless the pipe lines are carefully planned, however, trouble is likely to be experienced. Dead ends, needless loops in the pipe line, unnecessary fittings, and sharp bends should be avoided, as they often prove sources of trouble.

Inspection of an oil-pipe line that had given considerable trouble showed that one of several short loops leading to furnaces not included in the original lay-out was the cause of the trouble. Nearly all the sludge that found its way into the pipe line worked into this loop, and thus permitted only a small amount of oil to be forced through the pipe to the burner. The same trouble is often due to dead ends.

Requirements of Fuel System

The particular requirements of an efficient fuel oil distribution system are:

1. Ample capacity of tank suction line and suitable strainer on intake pipe.
2. Some means of preventing the suction line intake from being lowered into the sludge at the bottom of the tank.
3. Means for blowing or cleaning out the suction line.
4. A pressure pump that will maintain a nearly constant pressure.
5. Means for heating the oil in the storage tank. The latter requirement is important when the storage tank is subject to low winter temperatures.

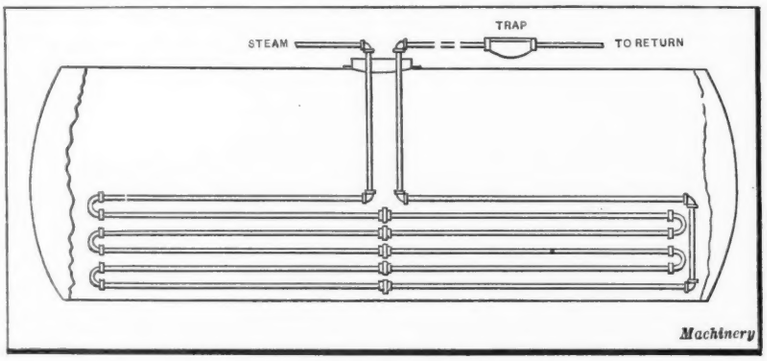


Fig. 1. Heating Coil installed in Oil Tank

Heating the Oil

The object in heating the fuel oil in the storage tank is to bring it to a consistency that will permit it to be readily pumped through the pipe lines to the burners. Generally it is not necessary to heat the oil to a higher temperature than 175 degrees F. In fact, any temperature between this point and 125 degrees F. will be found satisfactory for most forge shop systems, provided the pipes are not subject to undue cooling at some point between the tank and the burners. The temperature of heavy oils must, of course, be kept somewhat higher than that of light oils. The following table furnished by the Maxon Furnace & Engineering Co., Muncie, Ind., will serve as a guide in determining upon the proper temperature.

Baume Gravity Test	Degrees F.
28–32	125
26–28	150
24–26	180
20–24	190
15–20	200

In Fig. 1 is shown a heating coil installed in an oil storage tank. It will be noted that the coil is introduced into the tank through the top opening. It is inadvisable to provide any connections in the tank near the bottom. Should a bottom connection become broken off or develop a leak, the oil would all drain into the heating system.

Keeping Oil out of Heating System

An important point to remember in planning an oil fuel distribution system was brought to the writer's attention several years ago. The oil heating system in a certain plant was operated by steam at a pressure of 15 pounds per square inch, while the pressure of the oil system was 40 pounds per square inch. One day the coils in one of the small heaters broke, with the result that the oil-pump filled the heating system partly full of oil before the break was discovered. Since this occurrence, a sight drain has been used on the oil tank heating coils. This is a good feature when the heating is done by steam at a lower pressure than the oil pressure. The arrangement is something like that shown in Fig. 2. It was thought that the oil would be forced out through the trap, which no doubt would be the case, but just how much oil would work back along the pipe lines before this occurred is more or less problematical.

The upper view in Fig. 3 shows how the oil piping can be arranged to reduce the danger of oil being forced into the heating system. This method requires a pressure relief valve on the coil side of the globe valve. A non-return valve is also inserted between the relief valve and the globe valve. Should a leak occur in the coil within the tank, the check valve will prevent any considerable amount of oil from entering the pipe line, and the oil discharge from the relief valve will indicate that a leak has occurred.

It should be remembered that the oil in the storage tank need not be heated to the temperature often required or found advisable at the point of consumption. In fact, most systems provide sufficient heat in the storage tank to facilitate the pumping of the oil through the distributing system. A second heating operation, however, may sometimes be required at some point in the pipe line. The heating coil shown in Fig. 1 is suitable for small tanks up to one car capacity. In larger tanks it is advisable to build a heating coil around the intake pipe only, and not attempt to bring the entire tank of oil to the temperature required for circulation.

Suction or Intake Pipe

The suction line of the pump should be of ample size, taking into consideration the fact that the oil will sometimes be heavy and sluggish, particularly at seasons when it is not considered necessary to keep the heating system in constant operation. Whenever possible, the pump should be set about on a level with the top of the tank, in order to prevent syphonage of the oil from the tank should the suction line become broken. The discharge line may then be placed at any convenient level, as the pump will serve as a check valve.

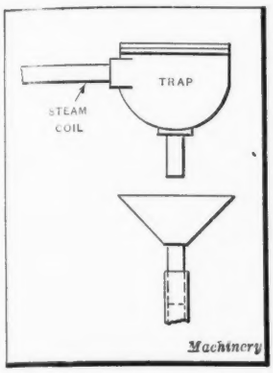


Fig. 2. Sight Drain for Oil Tank Heating Coils

The intake of the oil-pump must be protected by a strainer, and most pump manufacturers will not guarantee their product unless a strainer is employed. The strainer should be of sufficient capacity, the ratio between the area of the strainer and the pipe being about 30 or 35 to 1. The suction or low-pressure strainer should be of rather coarse mesh as compared with the strainer at the discharge end. It is the general practice to place a strainer near the pump on the suction line and have another strainer at the end of the intake pipe.

Suction Pipe Inlet

The inlet end of the suction pipe, including the strainer, should be kept near the oil level in the tank, in order to prevent it from entering the sludge and water that settles to the bottom of the tank.

In the lower view of Fig. 3 is shown a floating intake which the writer has used with considerable success. The end of the pipe is carried somewhat below the surface of the oil, being lowered and raised with the rise and fall of the oil level in the tank. This floating arrangement insures the feeding of fresh oil to the distributing system at all times. One of the advantages in keeping the intake near the surface is that the warmer oil which rises to the top is drawn in by the pump. Either a swing joint pipe or a flexible hose can be used for the floating intake. The strainer is secured to the end of the intake pipe, which is kept near the surface of the oil by the float, as indicated. Care should be taken to see that the tank is refilled before the oil level has dropped to a point that will permit the suction inlet to enter the water and sludge at the bottom of the tank. An auxiliary pump is used at regular intervals to remove the water.

Cleaning Clogged Pipes

A steam connection should be made near the pump to permit blowing out the suction lines. This is the simplest method of cleaning the pipe. Some condensation is introduced in the tank by this method, but this is preferable to a clogged suction line. Blow-out connections should be provided all along the piping system, including the distribution piping.

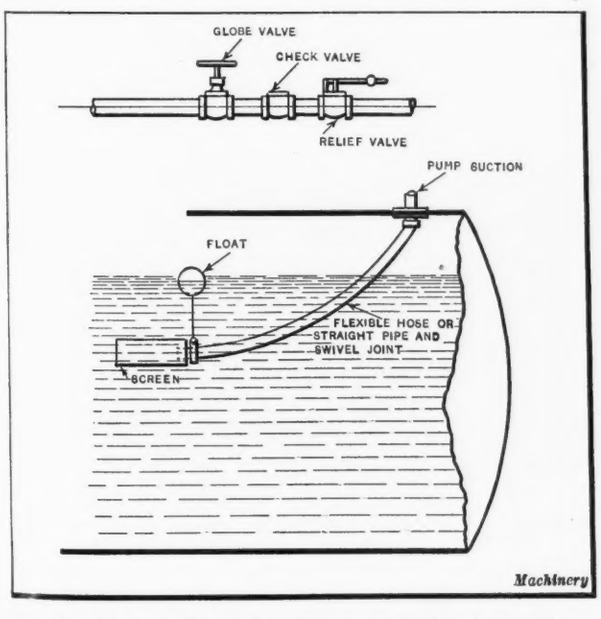


Fig. 3. Intake and By-pass Arrangements for Oil Fuel Supply System

Pump Requirements

An important factor in equipping a forge shop is the selection of the oil-pump. Obviously, a pump is required that will cause very little vibration in the system. If the pump produces pulsations in the flow of oil, this will cause the flame at the burners to vibrate or pulsate. Practically all piston pumps produce pulsations to a greater or less degree, unless an air cushion is provided. It is customary to provide an air tank or cushion chamber either directly on the pump, as shown in Fig. 4, or by the use of an auxiliary tank installed at some point along the distribution system.

A small amount of trapped air is carried over with the oil, and this usually separates from the oil in the air chamber, with the result that the system becomes airbound. This happened in the case of one system that came to the writer's attention. The cushioning tank had been installed at a high

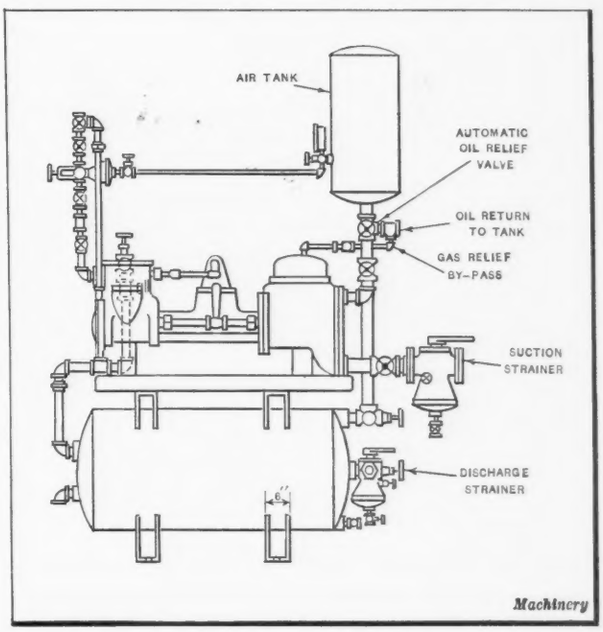


Fig. 4. Arrangement of Pump and Piping for Fuel Oil System

point in the room, and all oil passed through this tank. After a time, the flame from the burners appeared to vibrate and sputter. The cushioning tank of this system had been provided with an air relief, and after this had been opened slightly to allow air to escape, the flame at the burners became steady and no further trouble was experienced. All pipes leading downward should be supplied with an air relief valve at their highest point; otherwise they will become airbound and give trouble.

Centrifugal pumps, rotary pumps, and gear pumps are desirable types for oil supply systems, and they do not require an air cushioning chamber. The point to bear in mind is that the supply of oil must be steady and free from pulsations which will affect the burners. The pressure must be constant, which necessitates using a pump having a slightly excess capacity. The pump must be operated at a speed that will deliver more oil than is actually required, a by-pass being provided to take care of the excess oil. This results in maintaining a constant pressure at the burners. Where the pressure varies, the amount of oil fed to the furnaces also varies, making it impossible to maintain a steady or constant furnace temperature.

A constant pressure necessitates the use of a by-pass system controlled by a pressure regulator. The regulator must be so adjusted that all surplus oil will be returned to the tank and only as much oil passed into the distribution system as is required to maintain a constant pressure. The arrangement of a by-pass and pressure regulator is shown in the upper part of Fig. 4. The pipe for returning the surplus oil from the relief valve should run directly to the storage tank, instead of back into the suction line.

Design of Lathe Tailstocks

Typical Designs for Different Classes of Machines—Second of Three Articles

By FRED HORNER

THE first article of this series, published in January MACHINERY, page 393, dealt with various designs of tailstocks. Descriptions and illustrations of different forms of lathe beds or ways for supporting the tailstock and methods of clamping the tailstock spindle were included in the first article. Additional methods of supporting and clamping tailstocks are described in the present article.

Wedge Type of Clamp for Tailstock Spindle

The method employed to clamp or bind the spindle of the tailstock in a Pratt & Whitney 13-inch model B lathe is shown in Fig. 12. In this design there is a long wedge that engages the under side of the spindle when it is caused to slide forward by means of the handle, shaft, and cross-pin arrangement shown in the cross-sectional view in the upper right-hand corner of the illustration. This construction distributes the locking or clamping strain over a large portion of the spindle.

An eccentric clamping handle provides for locking the tailstock to the bed, the handle being placed in such a position that it does not interfere with the machining operations. The spindle is provided with graduations that facilitate drilling holes to exact depths. A tang-slot is cut through the spindle which permits the center to be removed with a

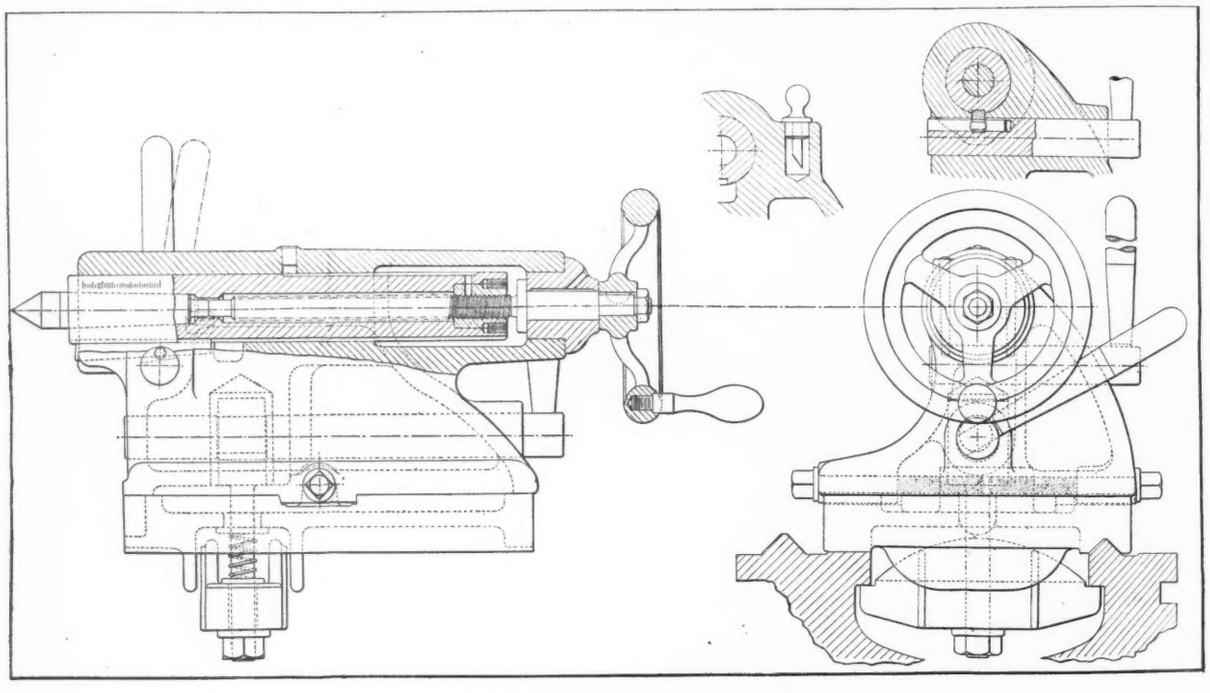


Fig. 12. Lathe Tailstock with Wedge Type Spindle Clamp

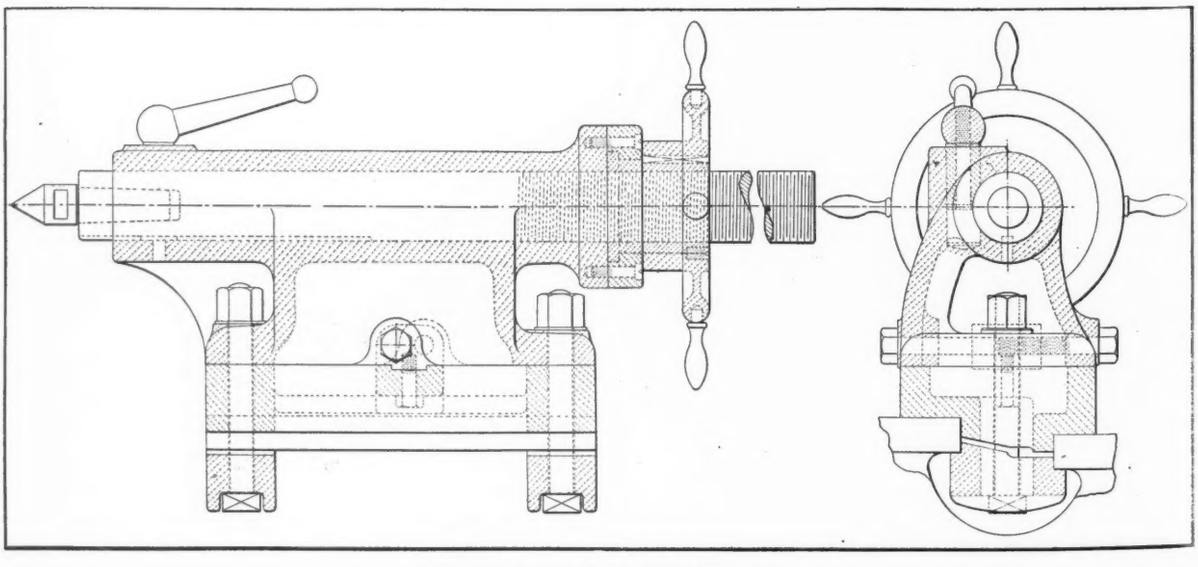


Fig. 13. Through Spindle Type of Tailstock

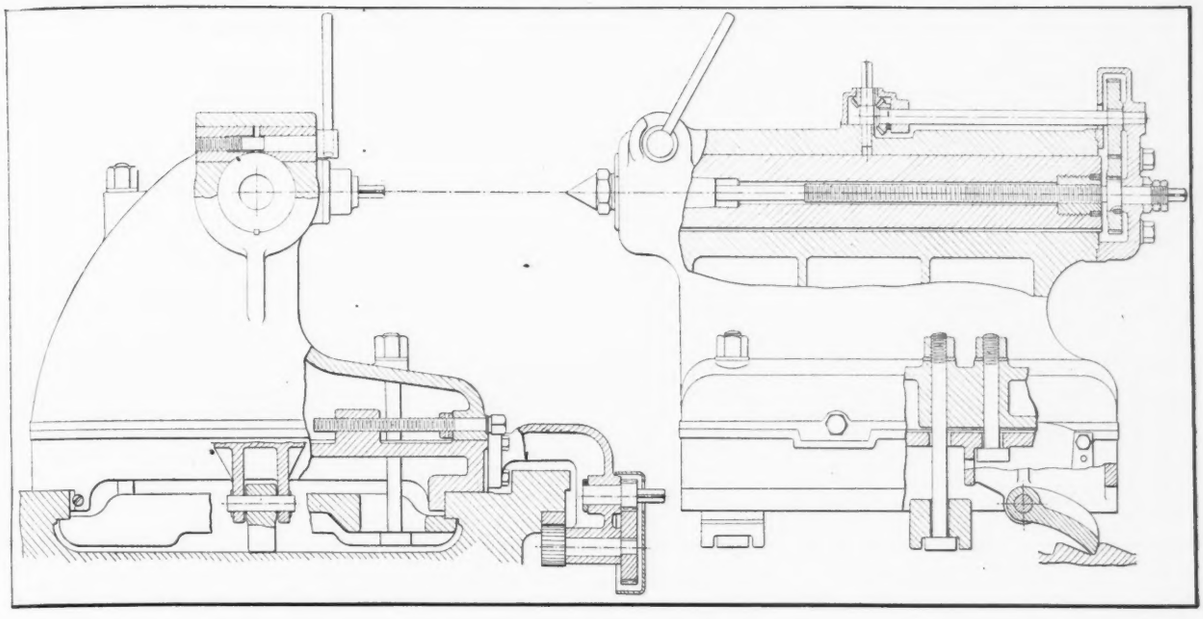


Fig. 14. Design of Tailstock of 48-inch Lathe

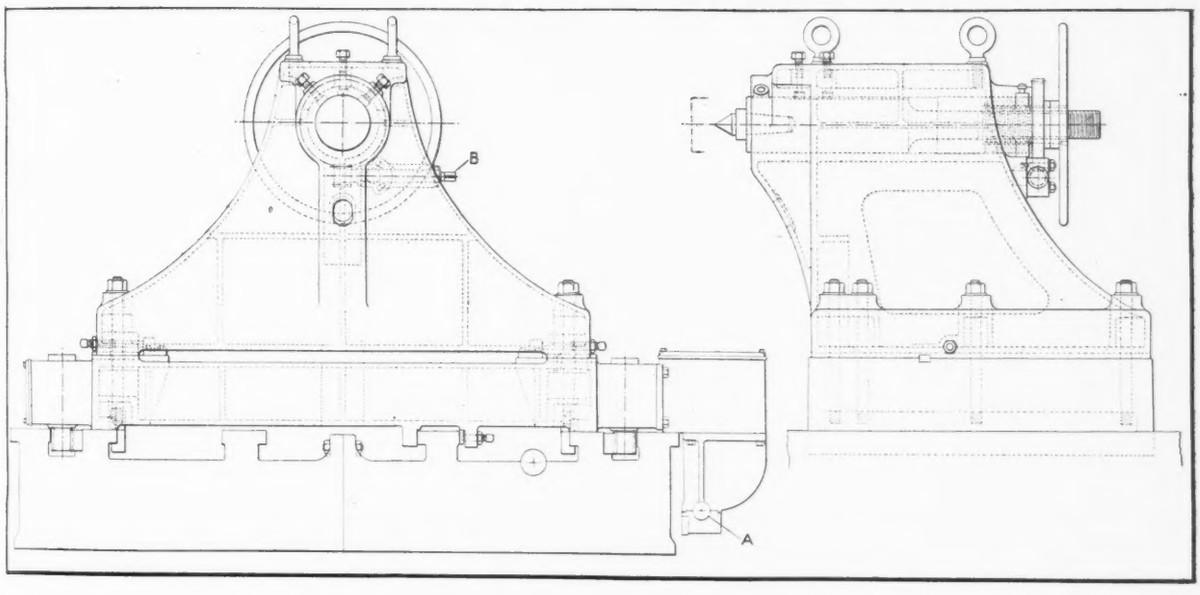


Fig. 15. Heavy-duty Tailstock of 81-inch Lathe

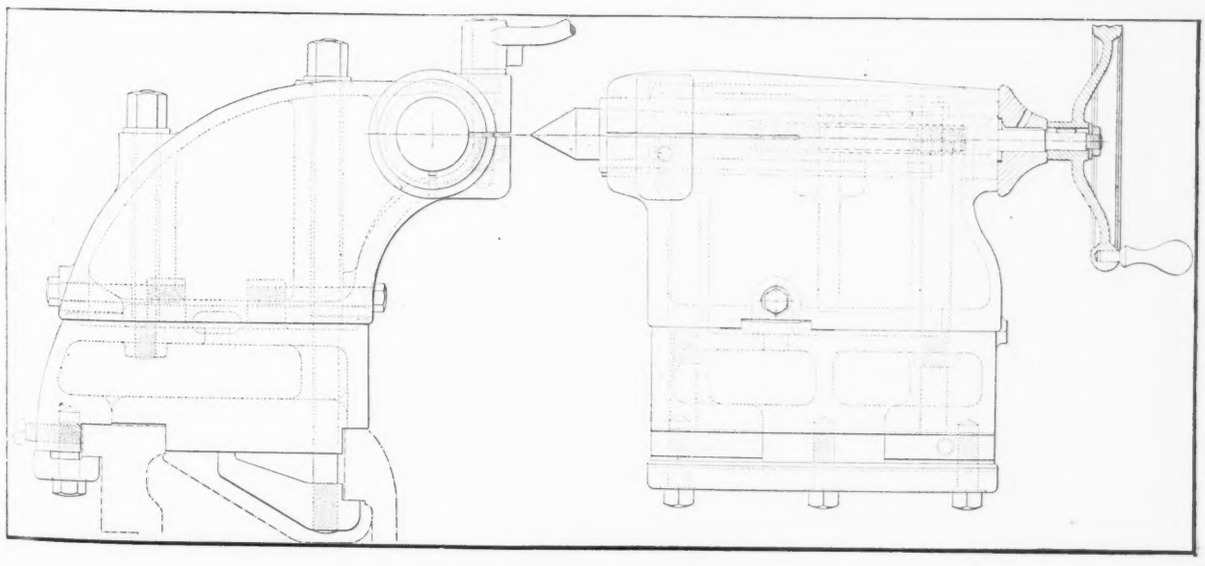


Fig. 16. Tailstock with Overhanging Spindle

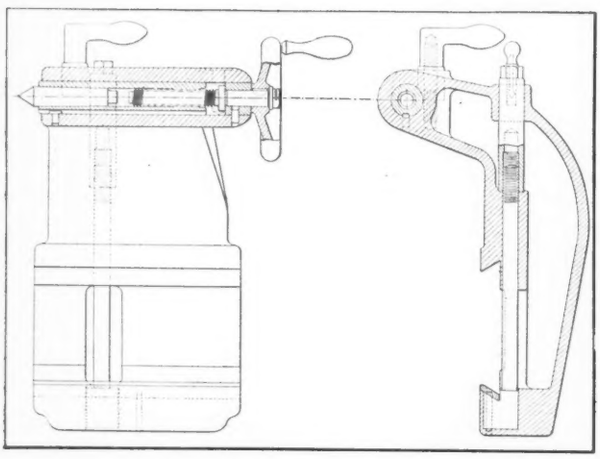


Fig. 17. Tailstock that permits Carriage to be fed past Spindle

drift key when desired. This eliminates the necessity of running the spindle back the whole length of its travel in order to eject the center by means of the feed-screw.

In Fig. 13 is shown a tailstock made by Henry Holmes & Co., Halifax, England, which is of very strong construction. The spindle is made solid, a left-hand square thread being cut on the outside to fit a revolving nut keyed to the handle. The nut has a collar which fits inside the retaining cap secured to the end of the tailstock casting. The total length of the spindle is 2 feet 11 inches, and the threaded part is 16 inches long. The clamp-bolt is of the vertical pad type.

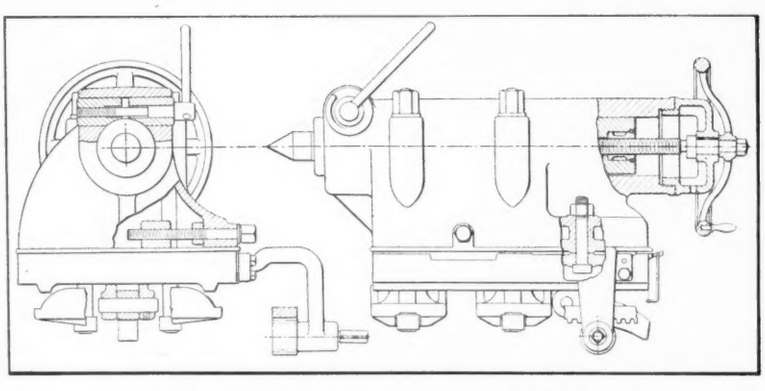


Fig. 18. Tailstock with Geared Clamping and Racking Controls

Tailstock of Heavy Design

On large lathes the design of the tailstock is affected by the form of the bed section, which is different from lathes of the average size. The control of the spindle often differs in that the handwheel is located nearer the front end of the tailstock. Powerful gearing is required to move the tailstock along the bed, and in some cases provision is made for connecting the tailstock to the carriage so that the former can be moved to the desired position by using the carriage power feed. Electric motors are often provided to operate the gearing that serves to feed the tailstock along the lathe bed.

In Fig. 18 is shown a loose type of tailstock designed for exceptionally heavy duty on a 30-inch lathe built by the Betts Machine Works. The 48-inch size lathe built by the same company is equipped with a tailstock having a base that is gibbed between the shears, as shown in Fig. 14. It will be noted that the racking pinion is driven by spur gears having a reduction in the gear ratio. A powerful binding clamp is employed to secure the spindle, which is adjusted by gearing connected with a short horizontal shaft located on the side of the tailstock casting at about the middle point. In the sectional view at the right, this shaft is shown at the top of the casting for convenience instead of in its correct position at the side of the spindle. The spindle can also be adjusted by attaching the crank to the squared end that projects beyond the two lock-nuts at the extreme right-hand end.

A 30-ton Tailstock for Heavy Work

Lathes having a center height of 123 inches and capable of swinging a piece of work 18 feet 6 inches in diameter over the carriages, with a distance of 40 feet between centers, have been made by Thomas Shanks & Co., Ltd., Johnstone, Scotland. Each of the two carriages used on these lathes weighs 21 tons, and the tailstock 30 tons. The chuck is capable of carrying a weight of 100 tons without any other support. In Fig. 15 is shown a tailstock used on a large lathe made by the same company which has a center height of 81 inches and a double bed 12 feet wide. The details of the adjusting mechanism are not shown, but power is obtained from a shaft *A*. This shaft is, in turn, driven by an auxiliary motor, and it also serves to locate the saddles. As indicated in the end elevation, there are two vertical pinions, one on each side of the tailstock which mesh with racks on the lathe bed. Eight hook-bolts are employed to secure the tailstock in place. The spindle, which is 12 inches in diameter, has two keys held in place by set-screws. Two screws placed 45 degrees apart, which exert pressure on pads that are in contact with the spindle, provide ample clamping pressure to hold the spindle securely in place. The extent of the permissible overhang of the tailstock spindle is indicated by the dot-and-dash lines. Eyebolts are screwed into tapped holes in the top of the casting to permit lifting tackle to be easily attached.

A duplex mechanism is included for feeding or forcing the spindle into the center hole in the work, the quick-acting mechanism being operated directly by the large handwheel that turns the spindle nut, while the slower and more powerful movement employed for the final setting is obtained by means of a worm-gear operated by a handle attached to the squared end of shaft *B*. The worm-shaft is fitted into the

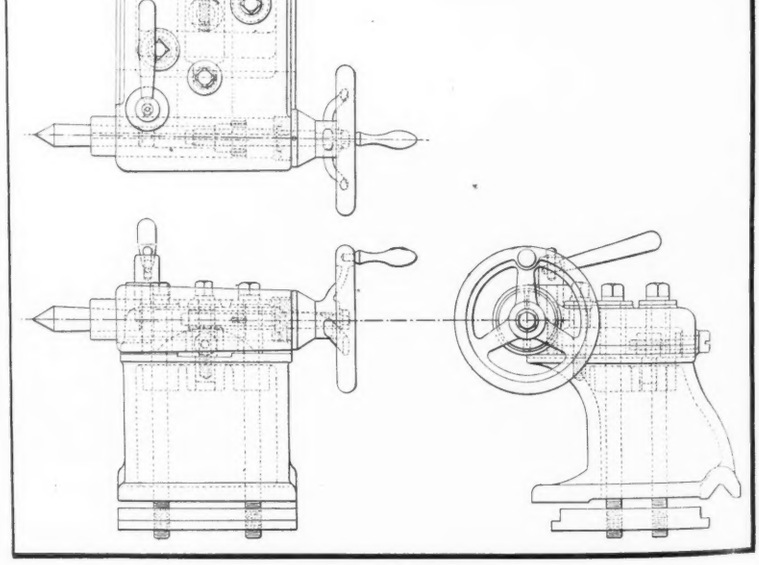


Fig. 19. Cross-adjustment Type of Tailstock

swivel bearing that is locked in place by two bolts and can be disengaged when the fast motion mechanism is used.

Some of the other large lathes for handling shafting are made double-ended, with duplicate headstocks and tailstocks, several saddles, roller steadyrests, and trepanning attachments. By removing one tailstock, the total length of the lathe bed, which is 100 feet, can be employed for turning operations. Ordinarily, however, both tailstocks are employed so that the lathe serves the same purpose as two ordinary lathes.

Tailstocks for Special Lathes

In most cases, special lathes developed for high-production work require tailstocks of unusual design. The special shape of lathe bed found on the LeBlond multi-cut lathe, for instance, required a special tailstock of the design shown in Fig. 16. The bed of this lathe is so designed that the carriage slides on the front sloped portion, while the headstock and tailstock slide on the rear section. The latter section consists of a broad flat rail or shear, and the tailstock, which may be of the usual or the quick-acting pattern, is held to the lip on the rear rail by two screws and a gib located underneath the ledge. The long clamp that holds the tailstock to the front shear is drawn up or tightened by means of two bolts. This form of lathe bed allows the head to have considerable overhang, as indicated by the end elevation view. The spindle binding or clamping device is of the split-end type, and a spring shown by dotted lines in the front elevation facilitates quick withdrawal of the spindle.

On the short-bed production lathe built by the Porter-Cable Machine Co., the tailstock, shown in Fig. 17, is mounted on a vertical dovetailed slide at the back of the bed.

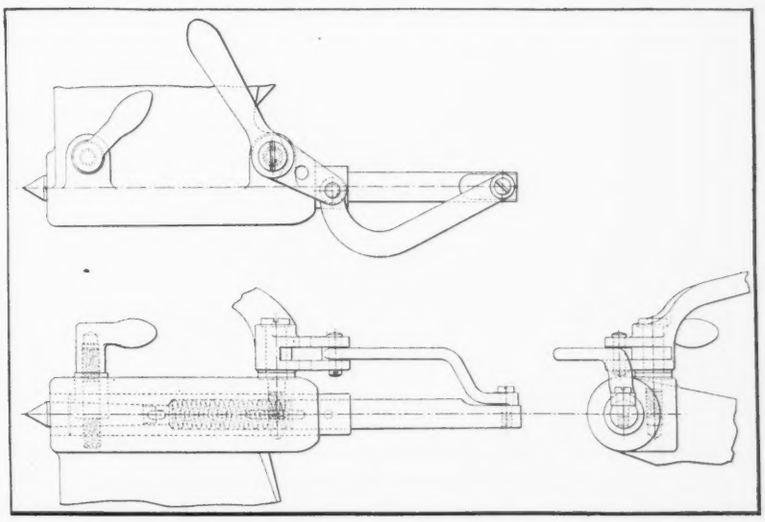


Fig. 20. Tailstock shown in Fig. 17 equipped with Lever Spindle Control

This construction permits the carriage to be fed underneath and past the tailstock spindle. The total length of the bed is thus decreased, as compared with the usual design. There is a gibbed strip at the bottom vee of this tailstock which is tightened by means of a hook-bolt, and a pad type of binder is provided for clamping the spindle. By removing the bushing from the spindle at the end nearest the handwheel, a different type of spindle operated by a lever as shown in Fig. 20, can be employed. A bent link which connects the outer end of the center with the forked arm of the actuating handle serves to withdraw the center. This arrangement permits the center to be properly seated in the work or work-arbor instantly, and the compression spring exerts sufficient pressure to hold the work between the centers. The lever is self-locking, and when light work is being handled, it is unnecessary to employ the spindle clamping pad.

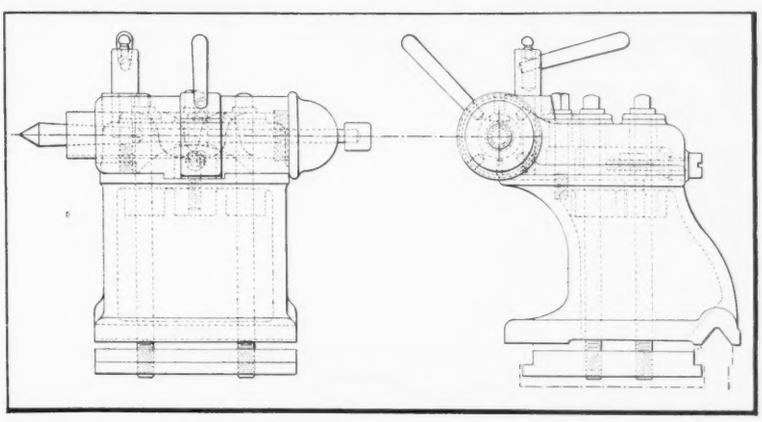


Fig. 21. Quick-acting Tailstock for Production Work

The Sundstrand short-bed production lathe, made by the Rockford Tool Co., utilizes the rear section of the bed as a tailstock guide. The tailstock has a vee and a flat bottom, as shown in Fig. 19. With this design, the carriage can be made to slide past and under the tailstock. The top of the tailstock is fitted with a slide to provide for crosswise adjustment. The quick-acting type of tailstock illustrated in Fig. 21 is designed primarily for the performance of turning operations on duplicate parts. A slight turn of the lever that is used for operating the central collar serves to advance and lock the spindle in position.

The two-section bed of the "Lo-swing" lathe, made by the Seneca Falls Machine Co., is so designed that the tailstock rests on two flat ways. This tailstock is provided with an adjusting strip for aligning and pulling up the plates. This lathe is so designed that the carriage can be fed past the tailstock, and the spindle is cut away or flattened, as shown in Fig. 22, to permit the turning of small-diameter work.

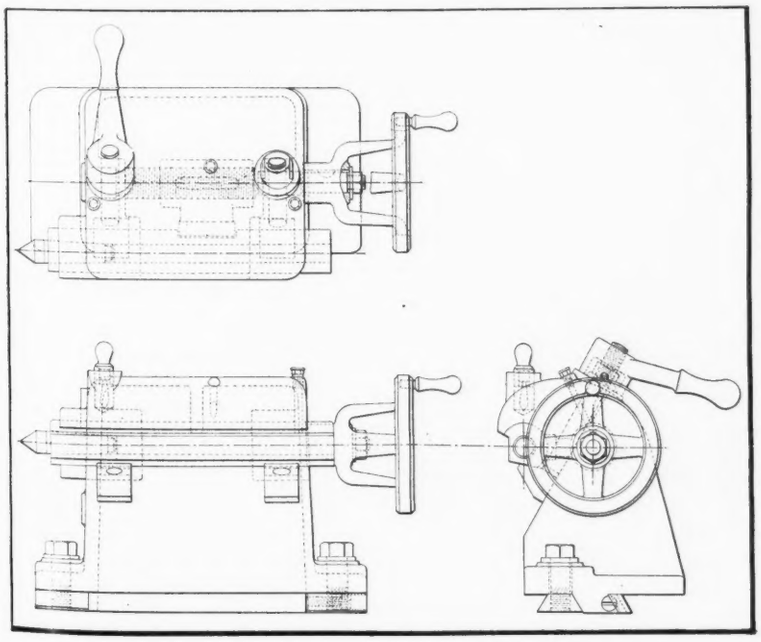


Fig. 22. Tailstock with Cut-away Spindle for turning Small Work

COMPOUNDS FOR CUTTING, GRINDING AND RUST PREVENTION*

By J. A. MAGUIRE, Oakley Chemical Co., New York City

A straight mineral oil is generally employed as the coolant for automatic machines used in manufacturing screw products. A straight mineral oil sometimes called spindle oil meets the requirements very well. For lathes and drill presses, a cutting compound made up of soluble oil and water is generally used. This compound may vary from one part of oil to ten parts of water, to one part of oil to forty parts of water. No matter what proportions are used, there is a tendency for the oil to separate from the water. This is apparent after the emulsion has stood in an idle machine for a few hours.

It is, therefore, of interest to note that one-half ounce of "Oakite" to each gallon of cutting emulsion will hold the oil in perfect suspension in the water. This keeps the point of the tool cooler, thereby lengthening its life, and enables more work to be done by the tool without regrinding. It also prevents rust spots on the work. The compound can also be used for a longer period without being renewed. When the compound becomes rancid, it is generally thrown out immediately, although some firms make a practice of putting a disinfectant in the solution to prevent this from occurring.

Cutting Compound Tests

In a test made on a four-spindle drill press, drilling holes 1 inch in diameter in 3/4-inch steel, the drills in the machine using the "Oakite" cutting compound drilled twice the number of holes with one grinding that the drills in the other machines drilled. This test was made over two years ago, and the improved cutting compound has been used in this plant ever since. Although one-half ounce of "Oakite" to the gallon serves the purpose, it is advisable to put in one ounce to the gallon at the start, because considerable compound is lost, and the usual practice is to add water to keep the tank full, thus weakening the solution. There is usually sufficient oil in the compound to take care of the dilution.

Grinding Compounds

A solution of "Oakite" in water will give good results as a grinding compound, but care must be taken to use a sufficient amount of compound to prevent the work from rusting. The conditions likely to cause rust should determine the proper amount to be used. Two ounces to the gallon will do all that four ounces to the gallon will do, as far as the machining operation is concerned, but the four-ounce solution has greater rust-preventing properties. Even the fact that the ground surfaces touch each other after grinding must be taken into consideration, as this condition will cause rust, and in order to avoid it, a solution having a strength of four ounces to the gallon should be used.

When an operator's hands are subject to wetting by the solution, it is necessary to add some soluble oil in order to prevent the removal of the natural oil from the skin, which would cause sore hands. In most grinding operations, it is not necessary for the operator to immerse his hands in the solution, even for changing the work.

Preventing Gumming of Wheels

An emulsion of soluble oil and water is used for most grinding machines. The oil tends to gum the wheel, but a compound with one-half ounce of "Oakite" to the gallon will prevent this, although it is advisable in some cases to use one ounce to the gallon, because of the dilution resulting from the addition of clear water. When this is done, the wheel will not gum, but will be kept free-cutting, and it will not need to be dressed as frequently as before. The saving here extends to the diamond used to dress the wheel.

There are certain types of grinding machines on which the advantages referred to are unusually important. One is the ring-wheel surface grinder for flat work. If the wheel loads, it will burn the work, and to dress the wheel, requires considerable time. By keeping the wheel from loading, the number of dressings required will be reduced at least 50 per cent. Another type is the centerless grinder. A wheel of the ordinary type and speed is used here to do the grinding, while a slowly revolving wheel, called an idler, is run in contact with the opposite side of the work. The function of the slow wheel is merely to feed the work past the other wheel. The writer has seen sal soda and soap used in these machines, the soap being used to give the work a slip in order to aid the idler, but where soluble oil is used, no soap is needed. In a test on a centerless grinder, the wheel of which had to be dressed every two days before using the compound, it was found that four times as much work could be turned out without dressing when using the compound, and it was possible to use the solution for a week.

Tests on Surface Grinder

Another test was run on a Blanchard surface grinder where, besides the loading of the wheel, there was trouble with the magnetic table rusting and causing poor contact. Here, also, the dressings were cut from four to one, and it was possible to use the solution twice as long as formerly; in addition, the trouble from the rust was eliminated.

Prevention of Stains, Corrosion, and Rust

Too often great pains are taken to rinse metal articles after cleaning, whereas, if the solution were allowed to dry on, there would be no need for rinsing.

A copper mill was having trouble in preventing copper sheets from tarnishing. The sheets were large, and the method was to run them through sulphuric acid, give them a hot rinse, run them through a steam dryer, and then stand them on edge until thoroughly cool, before they were piled. In spite of all this, the complaints were numerous, as the tarnish might not appear for a week or so later. It was apparent that the acid was not neutralized. When this was properly done, the sheets, after being run through the dryer, could be piled flat while hot, and after six weeks would show no tarnish. The solution used for neutralizing the acid also removed any tarnish that was already on the sheets.

In a plant manufacturing hydraulic brakes, it was customary to swab the finished bore of the cylinder with castor oil after cleaning, to prevent it from rusting. By using a suitable cleaner with rust-retarding properties, at two ounces to the gallon of water, and eliminating the rinse, it was proved that the bore would not rust. The swab with castor oil was then discontinued.

In another plant, the method was to run parts for roller bearings through a washer and then dip them in a tank of oil to keep them from rusting while awaiting assembly. Before assembly, the oil had to be washed off. By making up a cleaning solution with rust-preventing properties, it was possible to eliminate the use of the washing machine and the oil tank. A dip in the solution cleaned the work and, by eliminating the rinse, there was no trouble with rust.

In the case of a steel tube mill, a solution has been made up for removing the drawing compound from the tubes and rustproofing, which also gives a finish that formerly could be produced only by wire-brushing. A few years ago a steel mill decided to add a small percentage of copper to the sheet steel in order to improve its quality. One manufacturer of milk cans who had a large quantity of this steel on hand found that during the process of manufacture several picklings were necessary to remove rust. The cans were also pickled just previous to tinning. The acid, acting on the steel and not on the copper, left a sludge on the surface that seriously interfered with the tinning. Since neither acid nor alkali would remove it, it had to be wiped off. After some experimenting, a solution was found that removes the sludge completely in a few minutes. The work that was formerly pickled several times between operations is now pickled only once.

*Abstract of a paper read before the ninth annual sales conference of the Oakley Chemical Co., New York City, December 7 to 10.

Machining Hoist Load Wheels

Description of Tooling Equipments Used on a Turret Lathe

A TURRET lathe is used by the Wright Mfg. Co., Lisbon, Ohio, to finish sheaves or load wheels for chain hoists. The load wheels are steel castings with a chilled core, which come to the machine in the rough, as shown in Fig. 2, to be finished as illustrated in Fig. 3. The tooling up of this turret lathe presented several interesting problems, because of the hardness of the parts, the irregular shape, which made the parts difficult to hold, and the accuracy specified for the finished surfaces. Four different sizes of load wheels for 1/2-, 1-, 1 1/2- and 2-ton hoists are made, two chuckings being required for each size. In Fig. 6, which shows diagrammatically a cross-section through a typical load wheel, the small reference letters indicate the surfaces machined. The capital reference letters used in the other illustrations refer to the tools used for machining these surfaces. The machine and tooling equipments were supplied by the Warner & Swasey Co., Cleveland, Ohio.

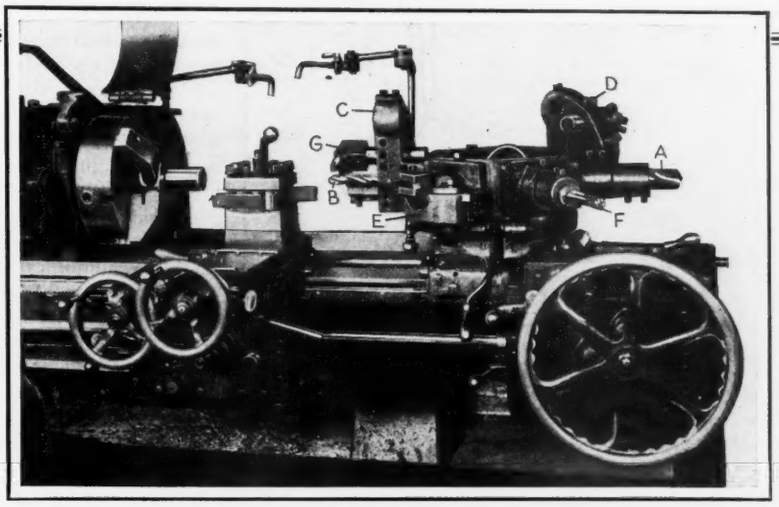


Fig. 1. Tooling provided for the First Chucking on the Load Wheels

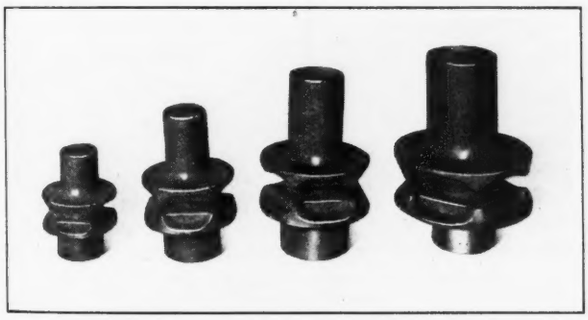


Fig. 2. Chain Hoist Load Wheels as they are delivered from the Foundry to the Turret Lathes

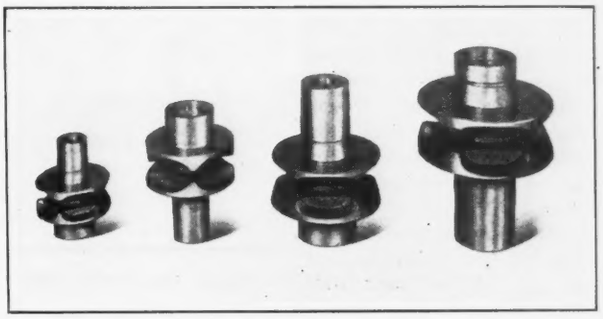


Fig. 3. Appearance of the Finished Load Wheels as they leave the Turret Lathes

The First Operation

One of the important points in machining the load wheels is to make the short end accurate with respect to the pockets in which the chain rides. Hence in the first operation, which consists of machining the long end, the load wheel is held in the chuck by jaws that are shaped to fit the pockets. The construction of these jaws for one size of load wheel may be seen in Figs. 1 and 5.

Drill *A* is used in the first step to start hole *h*, and at the same time, end *g* is rough-faced with a cutter on the square turret. Drill *B*, held in the plain turning and facing head *C*, is then advanced about one-fourth of the way through the wheel. At the same time, two angle-cutters in holder *G*, (also mounted in head *C*), rough-turn surfaces *m* and *l*, while surface *j* is rough-faced by a tool on the square turret.

The tools of another plain turning and facing head *D* next semi-finish-turn and semi-finish-bore the surfaces rough-machined by the tools in head *C*. Before head *D* advances sufficiently to cause interference, groove *o* is turned and end *g* finish-faced with cutters in the square turret. The angle-cutter holders of head *D* are equipped with a micrometer adjustment device. The tools in holder *E* next finish-turn surfaces *m* and *l* and bore hole *h*. This step is succeeded by the finishing of hole *h* with reamer *F*.

It will be noticed that the hexagon turret tools are not mounted on the turret in the order in which they are used

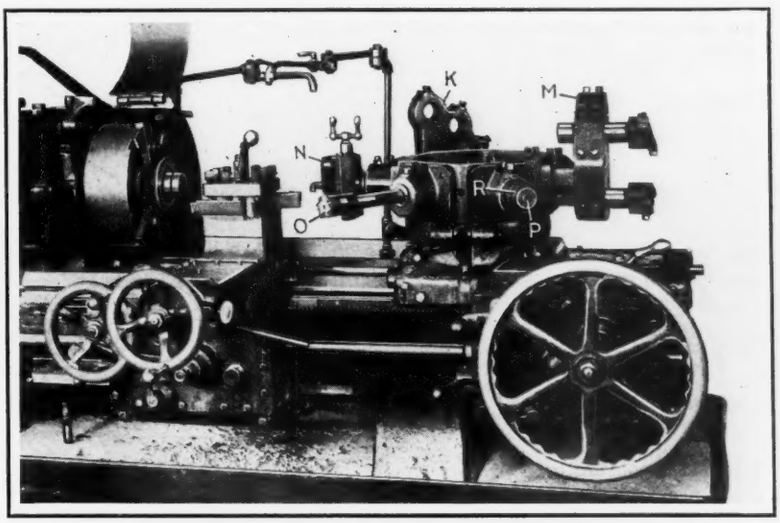


Fig. 4. Tooling Equipment used for the Second Chucking

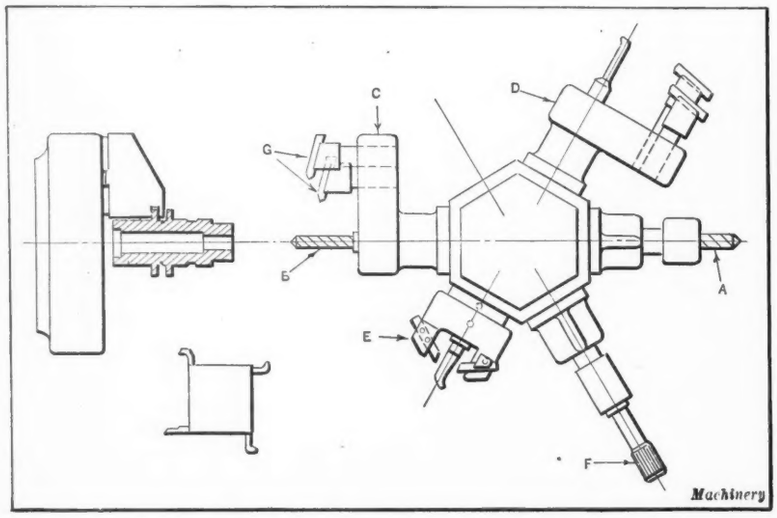


Fig. 5. Lay-out showing Detail Arrangement of Tooling provided for the First Chucking

for performing the various operations. The reason for this is that when the machine is changed from one set-up to another, it is not always necessary to change the position of certain tools bolted on the turret faces, such as the plain turning and facing heads *C* and *D*, Fig. 5, but only to change the position of the angle-cutter holders *G*. In this way, the set-up time is reduced to a minimum.

The Second Operation

In the second operation, the load wheel is placed in an adjustable faceplate fixture, being located on the turned diameter *m*, stopped against face *j* and held in contact with a hardened and ground locating ring by means of three clamps. The method may be clearly seen in Figs. 4 and 7. Drill *H* is used in the first step to start hole *a*, being fed to a depth of about 1/2 inch. At the same time, end *c* is rough-faced with a cutter in the square turret. Drill *H* is 1 3/4 inches in diameter.

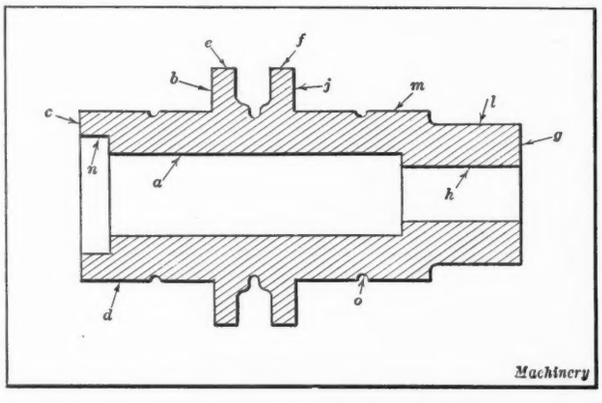


Fig. 6. Diagrammatic Illustration indicating the Different Surfaces machined

Drill *J* held in the plain turning and facing head *K*, is then advanced about three-fourths of the way through the load wheel. Simultaneously with this step, tools *L* in an angle-cutter holder turn surfaces *d* and *e*, and a cutter in the square turret faces surface *b*. A similar head *M* with micrometer adjustable angle-cutter holders is next used to finish-turn surfaces *d* and *e*.

The outer corner of flange *e* is then chamfered with a tool in the square turret, while counterbore *n* is being produced by a boring tool mounted in slide *N*. After reamer *O* has been used to size the counterbore, a ball bearing, such as shown at *P*, is slipped on arbor *R* and the arbor is advanced by means of the turret to press the ball bearing into the counterbore. The total floor-to-floor time of the two operations for the two-ton load wheel is 25 minutes; for the 1 1/2-ton load wheel, 21 minutes; for the 1-ton wheel, 15 minutes; and for the 1/2-ton wheel, 11 minutes.

* * *

To meet the requirements of the constantly increasing speeds of airplanes, air speed indicators have recently been developed that indicate up to 350 miles per hour.

DOES STANDARDIZATION PAY?

The Department of Commerce has been very active in aiding industry in eliminating waste due to the manufacture of too many types and sizes of articles in various branches. The activity of the department in this field is indicated by the fact that since this work was launched on a large scale in 1921 by Secretary Hoover, some 900 group conferences have been held under the auspices of the department, practically all at the request of the industries themselves, and 200 committees are now at work in cooperation with the Department of Commerce on various phases of this program of simplification in the different industries.

Since this cooperative service was started, over fifty simplifications have been achieved by the industries and trades concerned, resulting in an average reduction in varieties handled of 73 per cent. In eight typical cases, leaders in the field covered have estimated the annual savings due to simplification to be as follows:

Paving brick, $1,000,000; sheet steel, $2,400,000; steel reinforcing bars, $4,500,000; warehouse forms, $5,000,000; range boilers, $5,500,000; builders' hardware, $10,000,000; inquiry, purchase order, and invoice forms, $15,000,000; and lumber, as high as $200,000,000.

* * *

Probably few people outside of the textile industry realize that as regards the number of wage earners and the amount of wages paid and the value added by manufacture to the raw materials in this industry, it ranks first among all the industries of the United States. The textile mills proper employ a total of 1,100,000 people, and the value of their products amounts to over five and one-half billion dollars annually. In addition, 627,000 people are employed in making wearing apparel, producing products valued at about four billion dollars. Many observers believe that the textile industry is entering upon a period of prosperity, having gradually recovered from the serious depression of 1924. Because of the size of this industry, the conditions in it influence the prosperity of many other industries, including the machine-building fields.

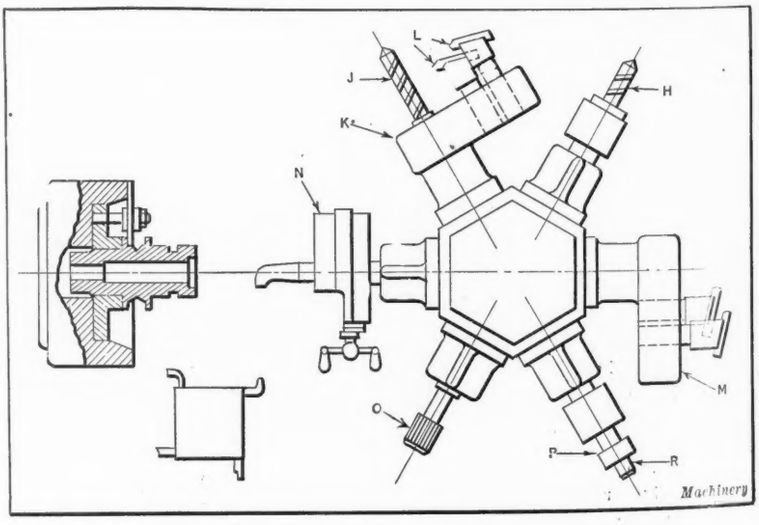


Fig. 7. Detail Arrangement of Tooling provided for the Second Chucking

Use of Dividing Head and Circular Attachment for Cam Milling

By HERBERT W. CABLE

THE barrel type of indexing cam shown on page 156 of MACHINERY'S book on "Mechanisms and Mechanical Movements" is an efficient design when applied to the rotary table of the station or indexing type of automatic machine. The section of the cam for the actual throw should be cast in a separate piece, to facilitate machining and also to allow the locking section, shown at *A*, Fig. 2, to be turned. This part should have exactly the same taper as the cam rollers and be fitted accurately between any pair of rollers. The rollers must, of course, be accurately spaced to insure positive locking and eliminate play in the idle position. The throw should have a relief cored at *B* for convenience in filing.

In order that the action will be as smooth as possible and without shock, particularly on heavy work, it is advisable to use a uniformly accelerated motion. To obtain the full benefit of this motion, the cam should be milled in such a way that the milling cutter follows the exact path that is later to be followed by the cam rollers. Owing to the fact that these rollers rotate about the center of the rotary table, there would be a slight error at the center of the cam if it were milled with a straight-line acceleration of the milling cutter, and this error would become greater as the radius of the center of the cam rollers became smaller.

A standard circular milling machine table can be used in milling the cam. The arrangement is shown diagrammatically in Fig. 1. The cam *C* is mounted on an arbor in the dividing head *D*, which, in turn, is mounted on the circular milling table *F* at a distance *R* from the center. The distance *R* is equal to the radius of the indexing cam rollers in the machine proper. The milling cutter is shown at *E*, the index-plate of the dividing head at *B*, and the index-plate of the circular table at *A*. The cam is shown at the central milling position. As the cam is turned in the dividing head one division, say X_1, by means of index-plate *B*, the circular table is turned a corresponding division *Y* by means of index-plate *A*, and the cutter *E* is dropped in and raised making a cut; then this procedure is repeated for the second division X_2, and so on.

The index-plate of the dividing head should have the proper number of holes to give the angular divisions obtained by dividing the total angle of cam rotation by the number of cuts to be taken. The number of holes in the index-plate of the circular milling table depends upon the design of the cam and is obtained with a formula given in the following.

The accelerated motion is effected by indexing the circular table a number of holes, between each cut, equal to the arithmetical progression 1, 3, 5, 7, 9, etc. To derive the formula, let

D = number of indexing divisions of whatever member is to be driven by the cam;

N = one-half the number of cuts taken in milling the entire cam; and

R = gear ratio of the circular milling table.

The indexing movements of the circular table are increased between cuts while milling the first half of the cam, and are decreased at the same rate while milling the second half, or in the same progression, so it is only necessary to have the correct number of holes in the index-plate to give the divisions for one-half the cam. In the arithmetical progression 1, 3, 5, 7, etc., let

n = number of terms;

s = sum of terms $= \frac{n}{2}(a + l)$;

d = difference $= 2$;

a = first term $= 1$; and

l = last term $= a + (n - 1)\,d$.

(See MACHINERY'S HANDBOOK, pages 102 and 103, sixth edition.)

Substituting,

$$l = 1 + (n - 1)\,2 = 1 + 2n - 2 = 2n - 1$$

$$s = \frac{n}{2}(1 + 2n - 1) = \frac{2n^2}{2} = n^2$$

Hence the total holes passed during half the milling of the cam is equal to the square of the number of cuts or N^2.

$\frac{360}{2D}$ = half of the angular throw of the cam

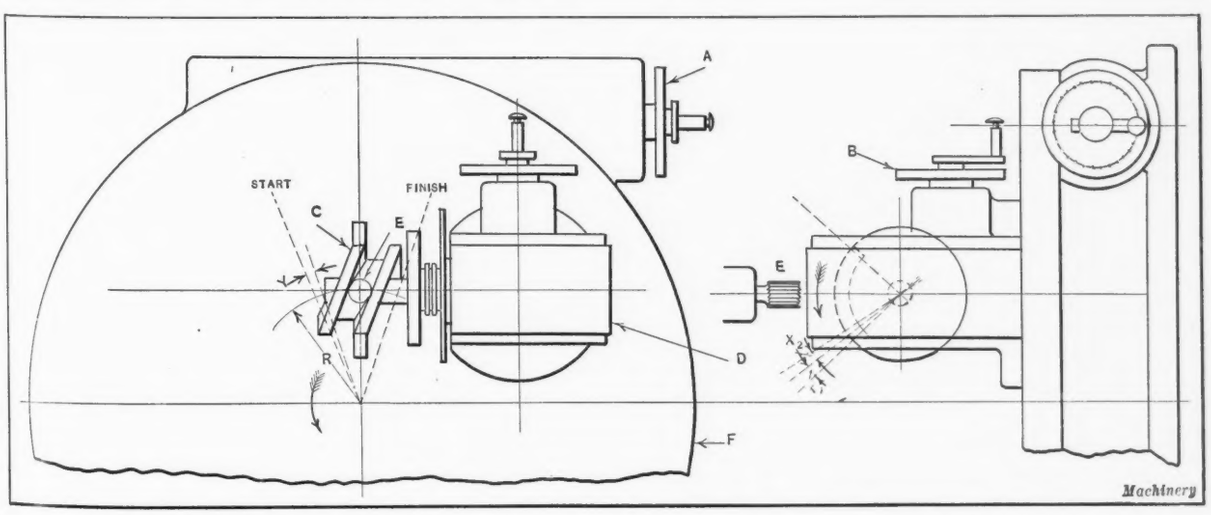


Fig. 1. Arrangement of Dividing Head and Circular Attachment for Cam Milling

$\frac{\frac{360}{2D}}{N^2}$ = angular throw or rotation of the circular table for each hole in the index-plate.

$\frac{360}{R}$ = angular rotation of circular table for a complete rotation of index-crank.

Let x = number of holes required in index-plate of circular table;

Then

$$x = \frac{360}{R} \div \frac{\frac{360}{2D}}{N^2}$$

Simplifying, $x = \frac{2DN^2}{R}$

A tabulation of the indexing of the circular table or the number of holes between cuts, etc., which should be furnished to the machinist is given in the table accompanying Fig. 2. This cam was used for a twelve-position index, and it was milled in forty cuts of 2 degrees each. The ratio of the circular milling table was 100 to 1. Substituting these values in the formula,

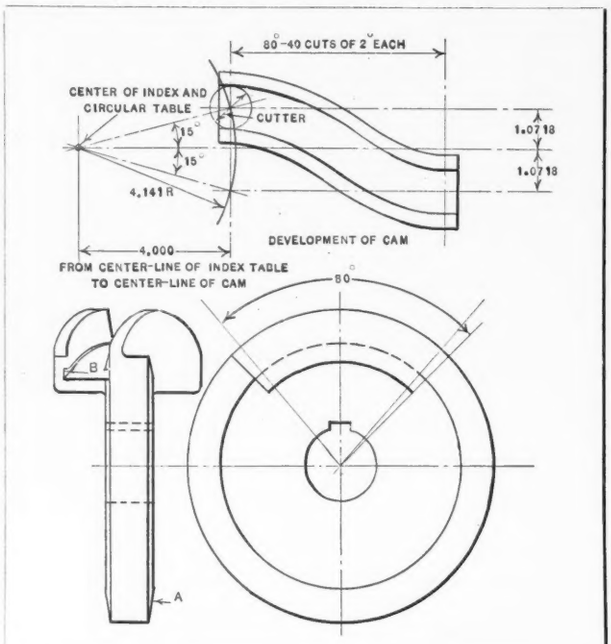
$$x = \frac{2 \times 12 \times 400}{100} = 96 \text{ holes}$$

in index-plate

Hence, one turn of the index-crank advances the cam 3.6 degrees, and 400 holes equals 4 1/6 turns or 15 degrees, or one half the angular throw of the cam.

* * *

In a statement by Julius Klein, director of the Bureau of Foreign and Domestic Commerce, Washington, D. C., it is pointed out that 1925 closed with the foreign trade of the United States in a highly satisfactory condition. Unless something unforeseen should arise to affect drastically either our production or the purchasing power of our leading markets, foreign trade in the coming year should be very good. During 1925, the export trade of the United States continued to advance, exceeding by more than 7 per cent the value in 1924. The total value of the exports from this country in 1925 amounted to $4,900,000,000, the largest figure since 1920. It is particularly noteworthy that our exports of finished manufactured goods have risen in a marked degree. Almost every class of manufactured articles was exported in greater quantity than ever before, except during the inflation years of 1919 and 1920. The most remarkable increase is in the automobile field, the number of automobiles exported being nearly 60 per cent greater than in 1924, which places the export trade of the automobile industry in a class surpassed only by cotton and mineral oils. Exports of machinery other than electrical and agricultural machinery increased in value more than 20 per cent, and the value of agricultural machinery exported increased more than 25 per cent.



Cut Number	Holes Between Cuts	Total No. Holes From Start	Full Turns From Start	Hole Number in Plate	Cut Number	Holes Between Cuts	Total No. Holes From Start	Full Turns From Start	Hole Number in Plate
1	1	1	0	1	21	39	439	4	55
2	3	4	0	4	22	37	476	4	92
3	5	9	0	9	23	35	511	5	31
4	7	16	0	16	24	33	544	5	64
5	9	25	0	25	25	31	575	5	95
6	11	36	0	36	26	29	604	6	28
7	13	49	0	49	27	27	631	6	55
8	15	64	0	64	28	25	656	6	80
9	17	81	0	81	29	23	679	7	7
10	19	100	1	4	30	21	700	7	28
11	21	121	1	25	31	19	719	7	47
12	23	144	1	48	32	17	736	7	64
13	25	169	1	73	33	15	751	7	79
14	27	196	2	4	34	13	764	7	92
15	29	225	2	33	35	11	775	8	7
16	31	256	2	64	36	9	784	8	16
17	33	289	3	1	37	7	791	8	23
18	35	324	3	36	38	5	796	8	28
19	37	361	3	73	39	3	799	8	31
20	39	400	4	16	40	1	800	8	32

Machinery

Fig. 2. Cam and Tabulated Data used in milling

GEAR LUBRICATION ON MATERIAL-HANDLING EQUIPMENT

A recent number of *Lubrication*, published by the Texas Co., New York City, contains the following information on gear lubrication which should be of value to those in charge of material-handling equipment in which gears are employed. In most types of material-handling machinery, gears and chains play an important part. In certain cases, they are enclosed, but in many others they are exposed to the elements. The gears frequently operate in an atmosphere of abrasive dust and dirt which tends to penetrate the lubricating film on the teeth, or becomes mixed with any excess lubricant and acts in much the same manner as a valve grinding compound. Therefore, gear lubrication and lubricants require very careful attention.

In the selection of suitable lubricants to meet such conditions, there are four distinct characteristics that require consideration, namely, viscosity, oiliness, adhesiveness, and the tendency to crack, congeal, or harden.

The viscosity of the lubricant should be commensurate with the method of its application, the amount of heat that may be encountered, and the pressure between the teeth. Relative to these factors, it is apparent that the lubricant must possess sufficient body to resist not only the squeezing out action due to pressure, but also the tendency toward increased fluidity which is brought about by higher temperatures.

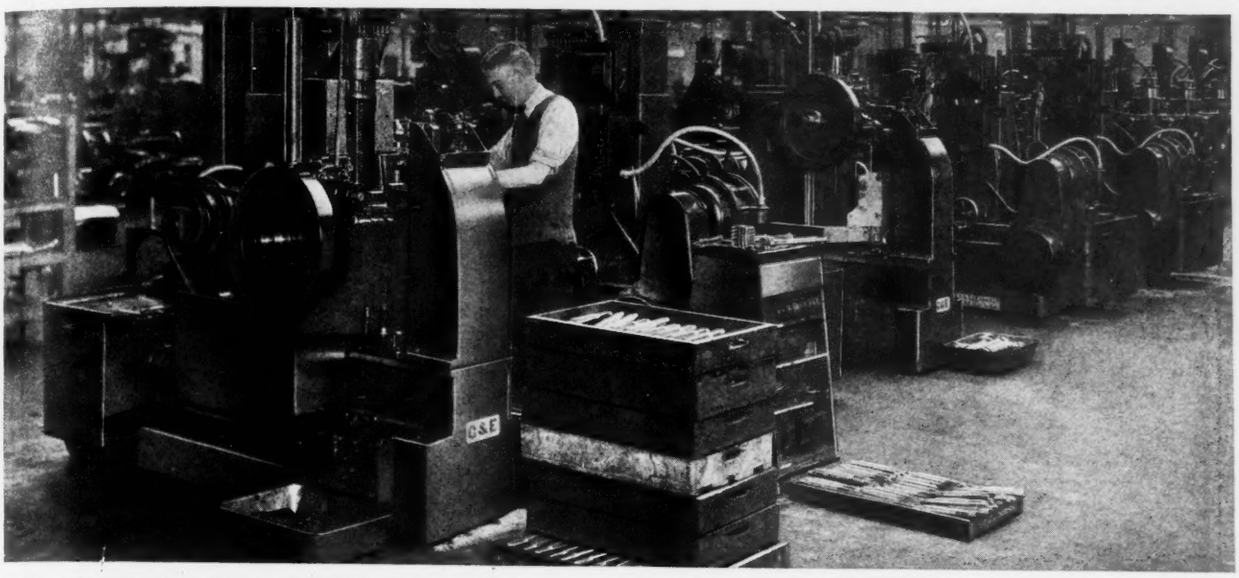
The gear lubricant should have sufficient oiliness or lubricating ability to prevent abnormal power losses due to solid and fluid friction. In addition, the greater the lubricating ability, the more readily will the gears and the chains function with a minimum amount of lubricant.

Maximum adhesiveness is required in order that the lubricant, when used under exposed or semi-enclosed conditions, will maintain a sufficient film on the teeth and effectively resist the action of centrifugal force.

Under low temperature conditions the least tendency to crack, congeal, or harden might easily interfere with lubrication to a marked degree. Under higher temperatures, there should be no tendency for the lubricants to carbonize and chip off, for this would have the same effect, with the result that the teeth might suffer materially.

* * *

A committee of the American Society for Testing Materials that has been investigating the effect of annealing on the properties of staybolts, reports that the results obtained indicate that the life of staybolts is probably doubled by proper annealing.



Hobbing Automobile Transmission Gears

High-production Methods Used in Roughing Out Gears at the New Ajax Automobile Plant

TRANSMISSION gears are rough-cut at the Ajax Motors Co., Racine, Wis., on Gould & Eberhardt hobbing machines of the manufacturing type, of which there is a battery of seven in the plant. Two of the machines are used for hobbing the splines in the transmission shaft, the long splines at one end being ground to size after heat-treatment, and the short splines at the other end being used as they come from the hobbing machine. Fig. 1 shows the machine used in hobbing three series of teeth on the cluster gear. The fourth gear cannot be hobbed because of the lack of clearance for the cutter, and so it is rough-cut in a Fellows gear shaper. All of the transmission gears are finished in that type of machine.

It is customary to run a large quantity of cluster gears through the machine illustrated in Fig. 1, with the machine set up for cutting one gear, then change the machine set-up for cutting the second gear of the cluster, and finally change the set-up again for cutting the third gear. It requires only between 3 1/2 and 4 minutes to change a set-up. This time is consumed in substituting the indexing gears to suit the number of teeth to be cut in the gear, adjusting the machine to suit the depth of cut, aligning the hob relative to the gear, and positioning the trip-dogs. The operation of the machine is entirely automatic except for reloading.

Types of Hobs Used

Double-thread 10-degree hooked ground hobs are used in cutting all transmission gears and the hobs are each of sufficient length to provide several cutting positions in order to secure maximum use between each grinding. With the exception of the 3-inch hob used for the small cluster gear, all hobs are 4 inches in diameter. Those used for the transmission-shaft splines are of the radial-tooth single-thread type, and are also 4 inches in diameter. All transmission gears are made of alloy steel forgings having a nickel content of 3.5 per cent and a carbon content of from 0.48 to 0.50 per cent. The transmission shaft is made of bar stock having the same nickel and carbon content. On each gear the teeth are of the stub type, with a pressure angle of 20 degrees and 7/9 diametral pitch.

Production on the Various Operations

In cutting the 13-tooth cluster gear, which has a face width of 9/16 inch, the production averages 45 gears per hour. About 220 gears can be cut per grinding of the hob, or 55 gears for each hob position. When the same machine is set up for cutting the 22-tooth gear, which has a face width of 5/8 inch, the production averages 35 gears per hour. In this instance, approximately 190 gears can be cut per grinding of the hob. Finally, in hobbing the 28-tooth gear, the production averages 30 gears per hour and again about 190 gears can be cut per hob grinding. In cutting each gear of the cluster, the hob runs at approximately 118 revolutions per minute, and the feed is 0.140 inch per revolution of the gear.

Fig. 2 illustrates an operation in which eight reverse idler gears are cut at each loading of the machine. These gears have 15 teeth and are 9/16 inch face width. They are loaded on the arbor of the machine with a collar between every two gears to support them near the teeth. The production averages 85 gears per hour, and about 480 gears are generally cut per hob grinding. In cutting this and the remaining gears, the hob speed is about 118 revolutions per minute, and the feed is usually 0.140 inch per revolution of the gear. The low and reverse sliding gear is also hobbed in lots of eight, as shown in Fig. 3. This gear has 28 teeth of 5/8 inch face width, and is hobbed at the rate of 48 per hour. In this case, the hob feed is 0.110 inch per revolution of gear. An average of 200 of these gears is maintained per grinding of the hob. Collars are also provided between each two of these gears.

In each example thus far described, the gears are held on an arbor that is supported at the top and bottom; Fig. 4 shows the operation of rough-hobbing the clutch shaft gear, which is carried in a fixture without a top support. The shaft of this gear is supported around the top bearing and piloted at the bottom in a small bearing. At the lower end, a pin is entered into one of the shaft splines to prevent the gear from turning. A wrench is applied to the screw-head near the bottom of the fixture to lock the gear for the operation. This gear has 16 teeth with a face width of 1 1/8 inches, and is produced at the rate of 57 per hour. Again, about 160 gears can be hobbed for each sharpening of the hob.

The second high-speed sliding gear has 22 teeth of 5/8 inch face width, and is of such a design that eight gears can be loaded on the arbor at one time. The production rate for this gear is 55 per hour, and about 240 gears are cut per grinding of the hob.

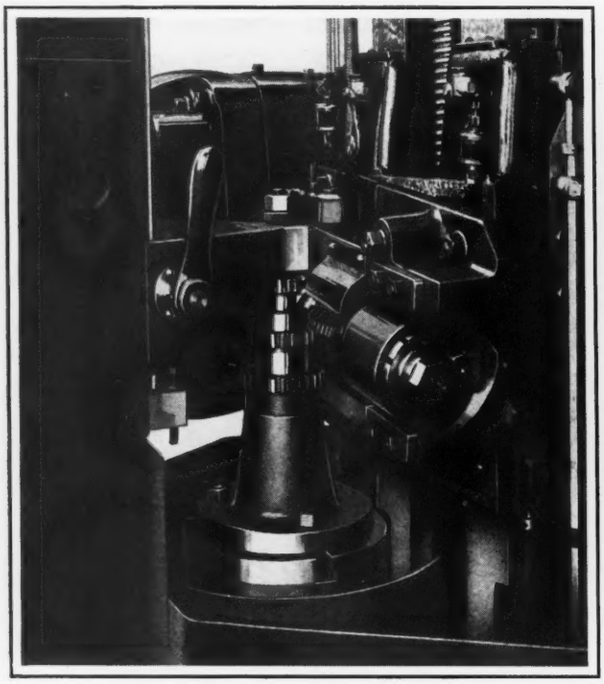


Fig. 1. Machine Set-up used in hobbing the Cluster Gear for the Ajax Automobile

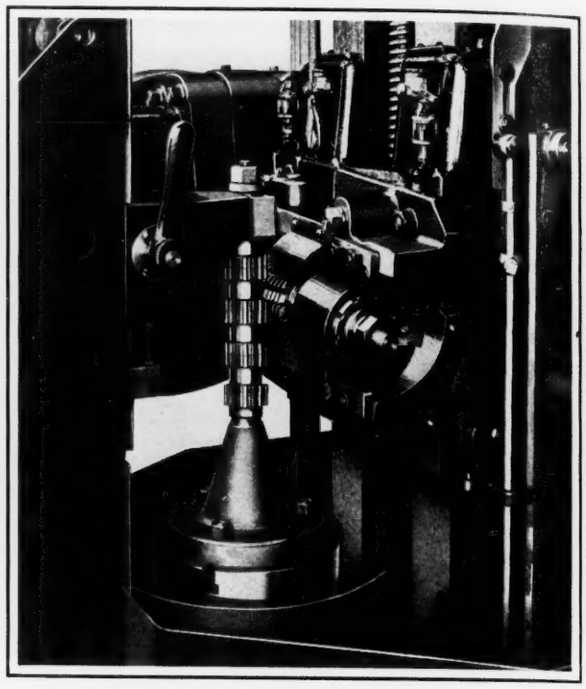


Fig. 2. Rough-hobbing the Reverse Idler Gear at the Rate of 85 per Hour

Hobbing the Transmission Shaft Splines

The short splines on the transmission shaft are six in number, and are cut on a portion of the shaft that is 1 1/8 inches in diameter. The splines are 0.279 inch wide and 1/16 inch deep, and are cut about 1 3/4 inches long. Thirty-six transmission shafts are averaged per hour in this operation and 300 shafts per hob position, between grindings. With three hob positions, this means a production of 900 shafts per grinding of the hob. In this operation, the splines are hobbed to the finished size ready for use.

On the opposite end of the transmission shaft, six splines are cut about 4 3/8 inches long to a width of 0.310 inch and a depth of 3/32 inch. Here the shaft is 1 1/4 inches in diameter. These splines are hobbed to size with the exception of a small allowance for grinding after heat-treatment. The production in this operation averages 23 shafts per hour and 100 shafts per hob position between hob grindings, or 300 shafts per grinding. The hob speed in cutting both ends of the shaft is 118 revolutions per minute. In hobbing the short splines, a feed of 0.110 inch per shaft revolution is employed, and in hobbing the long splines, a feed of 0.140 inch per shaft revolution.

* * *

An interesting effect of the use of buses has been the opening up of parts of the world formerly practically inaccessible to travelers. In many districts where traffic is so light that it would be out of the question to build railroads, bus lines have been established, maintaining regular traffic. For example, in French Morocco, 2100 miles of roads have been built by the government, and one of the bus operating companies even receives an indirect subsidy for maintaining bus transportation. In many other parts of the world, bus transportation promises to develop rapidly, and automobiles and buses will play an important role in carrying civilization to many remote parts of the world.

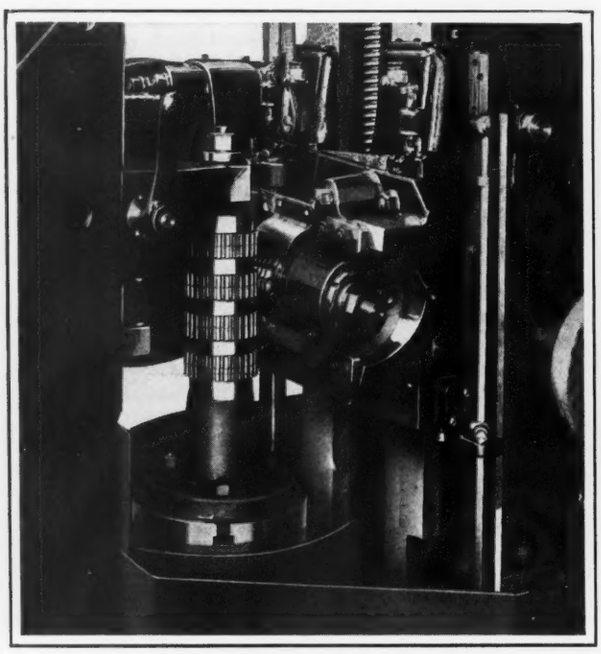


Fig. 3. Set-up used in hobbing the Low and Reverse Sliding Gear in Lots of Eight

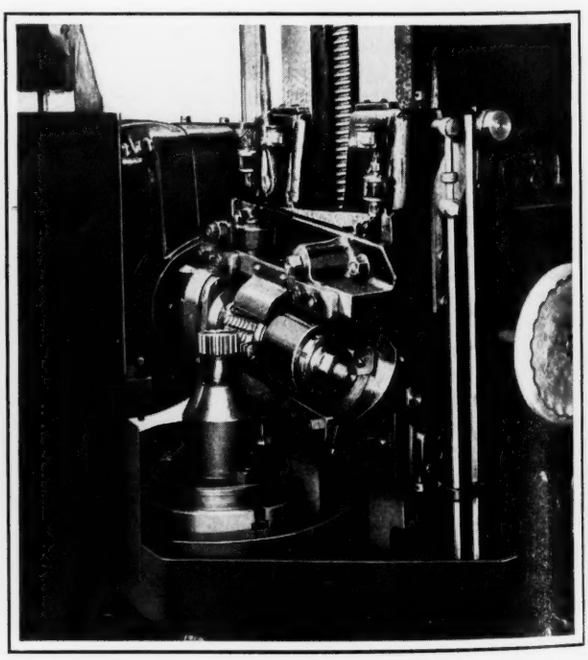


Fig. 4. Hobbing Operation on the Clutch Shaft Gear, the Shaft of which is firmly seated in the Work-holding Fixture

REPAIRING ALUMINUM ALLOY CASTINGS BY SOLDERING

By A. EYLES

The soldering of aluminum and aluminum alloy castings is generally considered to be a difficult process, and those who have had occasion to attempt such work have doubtless been surprised at the limited amount of information available on the subject. During a period covering twenty years, the writer has been engaged in research work involving the investigation of various methods of repairing aluminum and aluminum alloy castings. The following information, based on this experience, is presented here with the hope that it may prove of assistance to those who have occasion to repair aluminum or aluminum alloy castings.

Fractured and defective aluminum alloy castings can generally be repaired quite satisfactorily by the oxy-acetylene process, but often it is not desirable to heat the parts to be joined to the relatively high temperature necessary for welding, owing to the resulting distortion of the parts. In such cases, a means of joining the parts without heating them to a high temperature is desirable, and many special solder compositions have been patented for this purpose and are sold today with claims that sound reassuring. Of course, aluminum can be permanently repaired by soldering only when the solder can be made to adhere to the aluminum and when the joint thus made is not subject to deterioration.

Failure Caused by Corrosion

During the last twenty years the writer has tested many aluminum solders and has made joints with them that were to all appearances quite satisfactory and that seemed to be capable of retaining their strength for an indefinite period, as guaranteed by the manufacturers. In many instances, however, these guarantees have not been fulfilled. On subjecting new joints to severe tests, the metal was invariably broken at other points; and it was extremely difficult to make a new joint yield. After the lapse of a few months, however, the parting of the two pieces of metal at the soldered joint presented very little difficulty, thus proving that many of the so-called aluminum solders are not permanently satisfactory unless protected against corrosion.

To determine the feasibility of soldering aluminum with the various aluminum soldering compositions, a series of tests was made some months ago by the Bureau of Standards, the results of which are given here. It may not be out of place to mention that the bibliography included the article "Soldering and Brazing Aluminum," by the writer, published in December, 1914, MACHINERY. Experiments extending over the time that has elapsed since aluminum came into extensive use have demonstrated the fact that aluminum and aluminum alloys can be soldered but not so readily and effectively as other common metals; also that the number of solders available that will give a permanent joint is limited.

Heat for Soldering

It is well known that all forms of soldering require the application of the proper amount of heat in order to obtain a first-class joint, and that the temperature required varies with different metals, irrespective of the solder used. In many cases, failures in soldering aluminum alloy castings can be traced to incorrect regulation of the heat used in making the joint. In fact, it is a mistake to think of soldering aluminum as being the same process as that which the ordinary tinsmith uses in soldering tin and copper with a hot copper bit and a solder that will flow and follow the copper. Aluminum is not soldered in this manner, the practice being more like brazing with hard solders. When this fact is once established in the mind of a skilled mechanic, he will have but little difficulty in soldering aluminum, provided he has the right kind of solder and efficient equipment.

Cause of Corrosion

All metals or combinations of metal used for aluminum soldering are electrolytically electro-negative to aluminum. The solder joint is therefore attacked when exposed to moisture and becomes disintegrated rapidly. There is no solder for aluminum that is not affected in this way. In other words, a solder joint in aluminum, on exposure to moisture, will not remain permanent, as galvanic cells are set up which cause the joint to become rapidly disintegrated by auto-corrosion. One of the most severe tests to which a solder joint can be subjected is that of placing it in steam.

Joints that have the appearance of being satisfactory and that are apparently mechanically strong—within the limits of strength of the solder—fail quickly when exposed to steam. The joint fails by corrosion and disintegration of the solder at the bond junction. Hence solder joints should be protected against corrosion by a bitumastic paint or varnish. Temporary or emergency repairs in castings, however, can often be satisfactorily made with a good solder, when corrosion and disintegration of the joint near the exposed surface is of little consequence.

Composition of Aluminum Solder

The composition of the solder for aluminum and aluminum alloys may be varied within wide limits. It should consist of a tin base, with the addition of zinc or both zinc and aluminum, the chief aim being to produce a solder that can be reduced to a semi-fluid state at a suitable temperature for soldering.

A suitable solder for joining aluminum may be composed solely of tin and zinc, the amount of zinc employed ranging, perhaps, from 15 to 50 per cent. Another solder for aluminum consists of a mixture of tin, zinc, and aluminum. In this mixture, the amount of zinc may vary from 8 to 15 per cent, and the aluminum from 5 to 12 per cent, the amount of tin required being determined by the proportions of zinc and aluminum used. There is no reason why a good solder for aluminum need be brittle, as are some commercial varieties, and it is obviously desirable that the solder should not be brittle. Solders are best applied without a flux after the preliminary cleaning and tinning of the surface to be soldered is accomplished.

Tinning the Surfaces to be Joined

Tinning the surfaces of aluminum to be joined preparatory to soldering is an important operation. The process of tinning is accomplished by heating the surfaces to be joined —preferably with an atmospheric gas torch or a kerosene blow-torch—to a temperature somewhat above the fusing point of the solder, and then rubbing the surface with the point of a tinned steel tool which serves to remove the outside film and allows the solder to act upon the clean surface. The higher the temperature—within certain limits—at which the tinning is done, the better will be the adhesion of the tinned layer. When solders are used having the higher percentages of zinc and aluminum previously given, it is impossible for a workman to join the tinned members unless a comparatively high temperature is employed. This, of course, results in a much better joint. The tinned surfaces may, however, be joined by employing soft solder, in which case only the solder used for tinning need be of a special composition.

After the surfaces to be joined have been properly tinned, they are joined by pressing them together and again heating the castings to the required temperature, as determined by the composition of the solder. If necessary, the joint and the casting near it, may be finished or smoothed with a spatula just before the solder hardens, care being taken not to move the work until the solder has become thoroughly set. If a new section is required to be built up in the casting or an extensive hole filled in, the parts are packed or filled up with asbestos or other suitable material. In practice, it is often easier to rebuild small parts than to replace them.

Tensile Strength of Solder

The tensile strength of a good aluminum solder is about 7000 pounds per square inch. Solders having a higher tensile strength usually require such a high temperature for soldering that they are unsuitable for use in the manner described. The strength of a joint depends largely on the type or form

of the joint and the workmanship. A perfect union between the solder and aluminum is very difficult if not impossible to obtain, and too much dependence should not be placed on the strength of an aluminum soldered joint.

Cleaning Work to be Soldered

The repairing of a broken or cracked aluminum casting, such as the gear-box or oil sump of an automobile, which is usually in a very oily condition, is perhaps the most difficult job the mechanic encounters, particularly if the surfaces are so located that they cannot be scraped or filed. Grease must be removed before the work can be tinned, and the best method of doing this is to first burn out the oil and then brush the parts vigorously with a steel-wire brush. Soldered joints in large aluminum castings should be reinforced with brass plates which have previously been tinned. In many cases, it is necessary to employ jigs or fixtures to keep the parts in position while soldering. When the soldering operation is completed, care must be taken not to remove the jigs or clamps until the solder has become set. The repaired castings should be cooled by plunging them into cold water.

Salvaging New Castings

In salvaging new aluminum alloy castings, soldering is ordinarily employed only in the case of small and unimportant parts, where the object is mainly to improve the appearance of the finished casting. Porous castings or joints that leak slightly may be treated with a solution of sodium silicate and then baked. Small sand holes can be repaired by drilling out the holes and tapping them to receive threaded plugs made from 1/8- or 3/16-inch aluminum rods. The plugs should have at least three effective threads, and should be screwed tightly into place and cut off flush with the surface of the casting.

Repairing Broken Castings

Repairs should not be made on stressed members or on parts, the failure of which might endanger life. The failure of a casting, traceable to a repair made by soldering or welding, might result in considerable damage to the business or reputation of the manufacturer. However, there is a considerable field for the application of methodical repairing of defective aluminum or aluminum alloy castings used in building new machines and in repair work where the possible failure of the part would not entail serious consequences.

* * *

DIE-CASTINGS IN RADIO CONSTRUCTION

According to information recently obtained from Charles Pack, vice-president of the Doehler Die-Casting Co., Brooklyn, N. Y., die-castings are finding many uses in radio construction. Die-cast housings are being used for radio sets in preference to wood and hard rubber substitutes. Most metal parts on loud-speaker units are now die-cast. A part common to all radio receiving sets is the so-called variable condenser. Each condenser consists of two major parts known as "rotor" and "stator." Before the adoption of the die-cast condenser, these parts were made up of a large number of sheet-metal blades and accurately machined spacers, assembled together. A forty-blade condenser would, of necessity, be composed of forty sheet-metal blades and forty accurately machined spacers, besides a number of screws, shafts, etc. The possible variations due to inaccuracies in machining and assembly are readily apparent. By the die-casting process, a rotor or stator is produced integrally in one casting to a high degree of accuracy. Many radio engineers also contend that a die-cast condenser is far superior to an assembled condenser from an electrical efficiency standpoint.

A large number of condensers are also made with the blades stamped from sheet metal, inserted in the die-casting die, and cast together by the die-casting process. The all die-cast condenser and the sheet-metal blade die-cast condenser are rapidly replacing the assembled condenser, and it is safe to say that the latter type will soon disappear from the market.

INCH MARKS ON DRAWING DIMENSIONS

By JOHN HOMEWOOD

The article entitled "Placing Inch Marks Over a Decimal Point," on page 141 of October MACHINERY, brings up the question of the advisability of placing inch marks over the decimal point regardless of whether the number is whole or mixed. The use of the inch mark at the Navy Yard at Portsmouth, Va., as described is another example of the many little variations that make for inconsistency in our drafting-room practice. Like the ever increasing additions and amendments to our Laws, these variations in methods tend to make the interpretation of them more difficult.

As soon as we depart from what constitutes literal interpretation, an element of indecision enters, and often causes costly misunderstanding. At present we are endeavoring to arrive at greater uniformity in our drafting-room practice so that in times of necessity coordination will prevail between the Government and private manufacturers. We are trying to arrive at some definite understanding as to what constitutes the best means of expressing our ideas on drawings. Greater progress will be made if we consider every proposed change carefully, and avoid any drawings, the meaning of which is not definite.

While there is the advantage of the inch mark acting as a safeguard, in the event of the accidental removal of a decimal point, there is the greater disadvantage of ambiguity. In the case of the figure 2.5, if the inch marks are placed over the decimal point the meaning of the 5 is not definitely stated, whereas if the inch marks come after the figure 5 in the conventional manner, the meaning is definite and no misunderstanding can arise. One often hears such an expression as "two dollars and a half." Literally what does this mean—two dollars and a half of what? The more definite expression would be two and a half dollars. While two dollars and a half is commonly understood as being the equivalent of two and a half dollars, let us not take it for granted that 2.5 with the inch marks over the decimal point is commonly understood to mean 2.5 inches. If we are going to use the decimal point as an indication of extreme accuracy, the writer believes it would be unwise to employ any new system which could possibly introduce any misunderstanding.

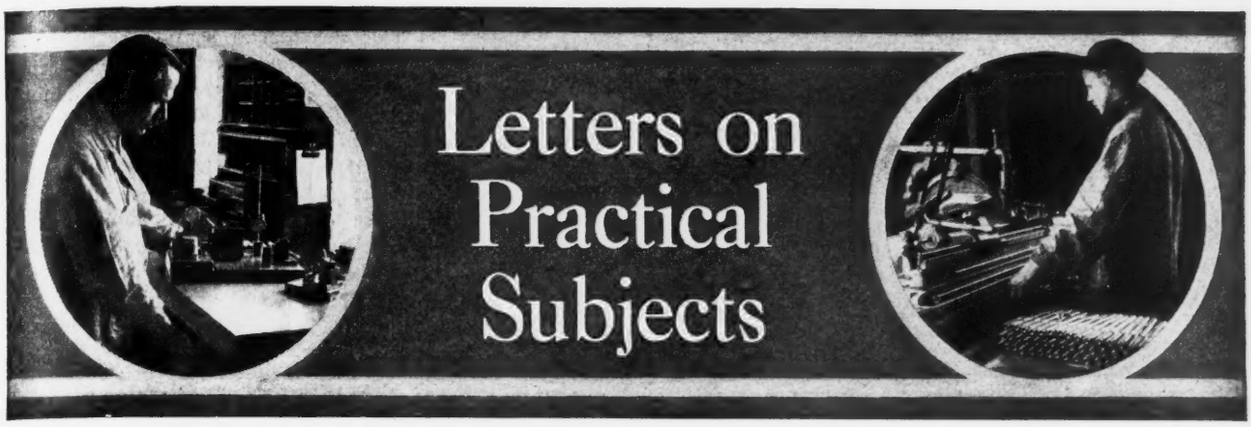
* * *

SAVING AUTOMOBILE TIRES

According to a statement authorized by the National Automobile Chamber of Commerce, following a meeting with Secretary Hoover in the United States Department of Commerce at Washington, attended by officials of the Automobile Chamber of Commerce and of the Rubber Association of America, it was decided to institute a campaign of education among tire users with a view to lessening the demand for crude rubber, Mr. Hoover has been making a strong fight against the tendency of foreign governments to create combinations and monopolies and to fix prices on important raw materials imported into this country. Because of the extraordinarily high prices of rubber, the House of Representatives has authorized an investigation of the British rubber restriction plan and other government plans for artificially increasing prices.

There is no real shortage of rubber, and plans to limit the amount of crude rubber that can be shipped by planters from British dominions are said to be unnecessary. The United States uses 70 per cent of the world's rubber. If a fair price is 36 cents a pound, present prices of around a dollar a pound will, according to Secretary Hoover, cost the American public $660,000,000 a year, or from $20 to $30 per set for light automobile tires and from $50 to $70 per set for heavy car tires.

In order to save rubber tires, users are encouraged to obtain the greatest possible mileage by maintaining proper air pressures, making repairs promptly, using brakes carefully, and rounding corners at slow speed. It is believed that the tire mileage of a set of tires could be increased 25 per cent if these precautions were observed.



BENDING STEEL RODS ON A SHAPER

Six hundred pieces of 3/8-inch cold-rolled steel rod were required to be bent to the shape shown in Fig. 1. This appeared to be either a long job for the blacksmith or a case in which a power press should be employed. The latter method would, of course, necessitate the building of an expensive set of dies. As the blacksmith was overloaded with work and it was desirable to avoid the building of dies, some other method of bending the pieces was sought, with the result that a shaper was pressed into service. A simple and inexpensive fixture built to handle the bending job on the shaper is shown in Fig. 2, while the bending tool is shown in Fig. 3.

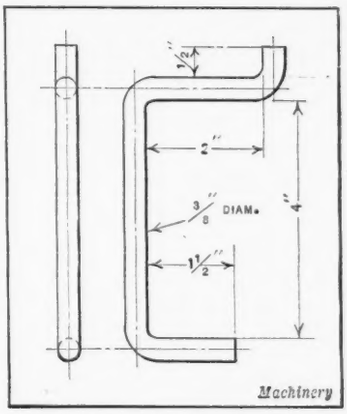


Fig. 1. Steel Rod bent on Shaper

The anvil block *A* and a plain block *B*, Fig. 2, were bolted and doweled to the face of a 6- by 6-inch angle-plate. The two pins *C* were made drive fits in properly located holes in the angle-plate. Two holes drilled in the base of the plate received the T-bolts employed to hold the fixture to the table of the shaper. The upper corner of the anvil block was hardened to withstand the wear incident to bending, and the upper edge was machined at an angle of about 6 degrees to provide clearance and relief.

The bending tool, Fig. 3, was made up of flat cold-rolled stock and provided with hardened tool-steel rolls. The upper arm *A* is designed to fit the toolpost of the shaper, and the horizontal arm is cut away at *B* to provide clearance for the clapper-box, so that the end of the arm will have a good bearing against the under side of the shaper head. The bending rollers *C* and *D* are grooved, as indicated in the illustration.

When the fixture is in operation, it is set up on the shaper table as shown in Fig. 4, being wedged up to an angle of about 3 degrees and secured in place by the T-bolts. The bending tool is clamped in the toolpost and the machine set for a long slow stroke. Because of the springy nature of the material being bent, the slight additional bend produced by tilting the jig is necessary in order to form a right-angle bend on the finished piece. The angle of 3 degrees was found by experiment to be sufficient for this particular grade and size of material, but for other sizes or grades, the angle would probably be somewhat different. When the bending tool is in operation, the small roller makes an initial bend in the work, and the larger roller completes the bend. This procedure was found to be more practical than to have a single roller complete the bend.

The order in which the bends were made is shown by the diagram Fig. 5. It has been found better to carry the whole lot of rods through one bend instead of trying to complete all three bends on one piece before taking up the next piece. In order to hold the work at the proper height for the first bend, a stop-block is bolted to the vertical face of the machine table. The first bend is the simplest and is made the quickest, one piece being bent at each stroke, using the slowest speed and a 16-inch stroke. The second and third bends could not be accomplished with less than two strokes, as it was found necessary to tap the bent piece in order to loosen it from the form. Thus the piece could not be removed from the form in time to permit another piece to be inserted.

By performing the bending operations as described, the whole lot of six hundred pieces was completed in about half a day. The application of the method of forming rods described is limited by the power of the machine employed. The bending of the 3/8-inch material was well within the capacity of the ordinary shop shaper, and it seems probable

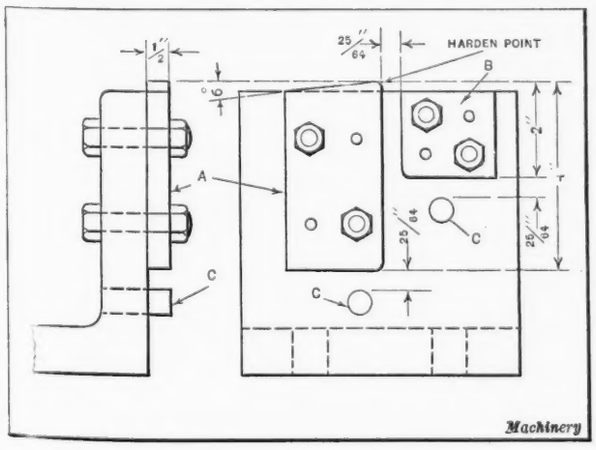


Fig. 2. Fixture used in bending Piece shown in Fig. 1

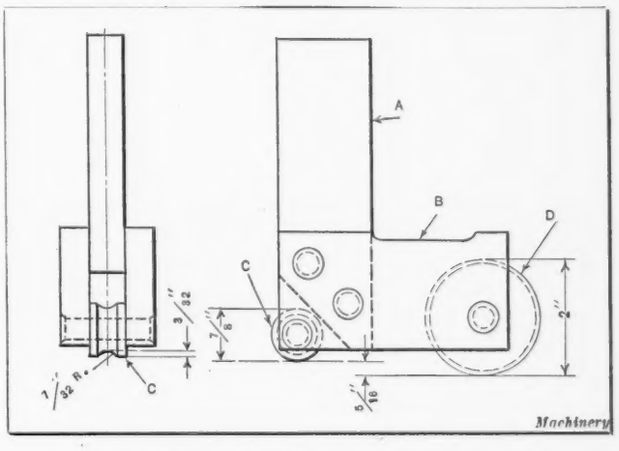


Fig. 3. Bending Tool used with Fixture shown in Fig. 2

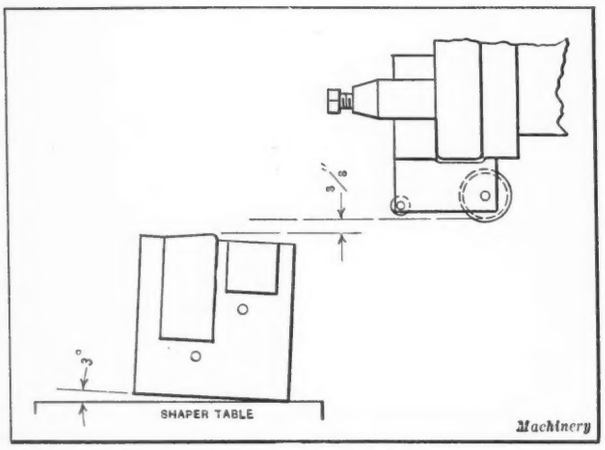


Fig. 4. Shaper Set-up for bending Steel Rod

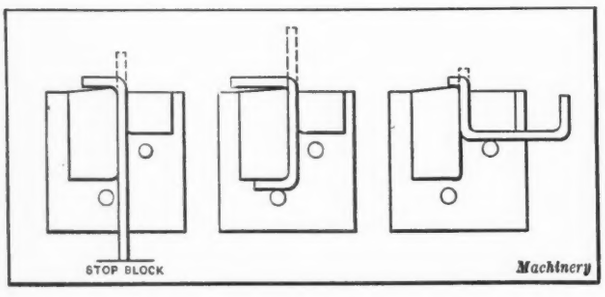


Fig. 5. Sequence of Operations in bending Part shown in Fig. 1

that even larger stock could be handled successfully. About the only precaution to be observed in applying the method is to make sure that the length of each end to be bent over is not less than twice the diameter of the stock.

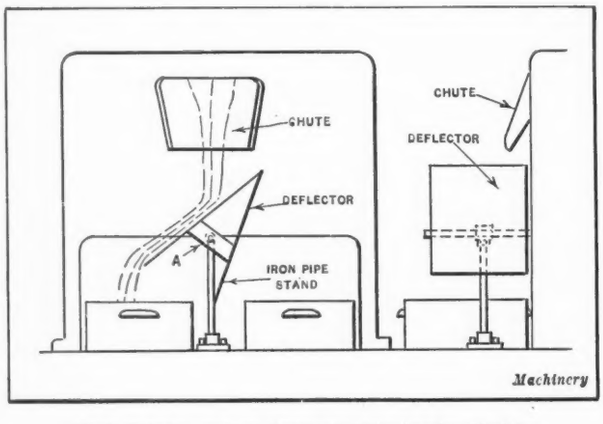
Pensacola, Fla. FRANCIS M. WESTON

WORK DEFLECTOR FOR AUTOMATIC MACHINES

Practically the only attention required by certain automatic machines is the changing of the boxes that catch the work. One concern engaged in the manufacture of wire goods uses a simple but effective device to facilitate changing the work-boxes as they become filled. Previous to adopting this device, a machine would be stopped for a moment while the box was being changed, to prevent some of the pieces from being shot out on the floor, or else an attempt would be made to displace the full box with an empty one. Sometimes this could be done successfully, but often the attempt failed.

The device shown diagrammatically in the accompanying illustration takes the form of a deflector which changes the direction of the work as it falls down the chute. A stand made up of iron pipe and pipe fittings is fastened in the proper position on the floor. This stand carries the deflector plate which is made of sheet metal bent to a triangular shape. The side pieces *A* are folded over at each end, and punched or drilled to give a loose fit over the iron piping. When in use, a box is placed on each side of the deflector stand, which is fastened to the floor under the middle point of the chute. When the deflector plate is tipped over to one side, the work is directed into one of the boxes, and when this has become full, the plate is tipped to the other side so that the work is deflected into the empty box. This permits replacing the filled boxes without any of the pieces falling to the floor.

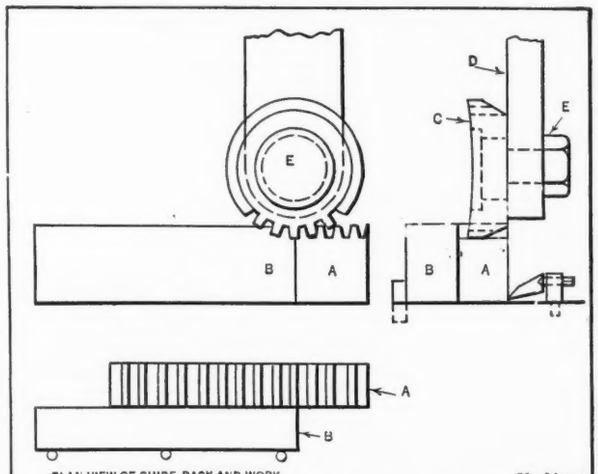
Montreal, Canada NORMAN MOORE



Work Deflector used on Automatic Wire-forming Machine

CUTTING RACKS ON A PLANER

A special rack of 5 pitch, 2 1/2 inches wide, was required for a certain machine. Such a rack could not be purchased ready made, and to obtain it on special order would have required considerable time and caused delay in completing the machine on which it was to be used. As there was a rack-cutting attachment for a shaper in the shop, of the type described in June MACHINERY on page 767, it was decided to cut the special rack with this equipment. However, the shaper proved to be too light for the job, and a similar arrangement was used on the planer instead. In this case a short piece of an old rack *A* was used to guide the Fellows gear shaper cutter *C* which was mounted on a holder *D*. The arrangement of the rack and the work will be understood by referring to the plan view of the illustration.



Set-up used in cutting Rack

The short rack *A* together with the work *B* was fastened to the planer table, the rack being placed at one side and projecting beyond the work a few inches. The reason for placing the rack in this manner was to make it possible to set the cutter to the correct depth and start cutting the rack teeth to the required depth from the beginning. When the feed was engaged, the cutter turned in mesh with the rack, thus producing teeth on the work *B* of the same pitch as those on rack *A*.

It was necessary, of course, to have the cutter made a good running fit on the stud *E*. The time required for cutting a rack of the size described, having a length of 24 inches, was approximately three hours.

Astoria, Long Island, N. Y. D. SINGER

LENGTH OF MILLING CUTTER TRAVEL

In estimating the time required for milling machine operations, it is necessary to determine the length of the table travel. On high-production work, a small error in determining the length of travel will introduce a wide variation in the estimated daily production. The accompanying chart

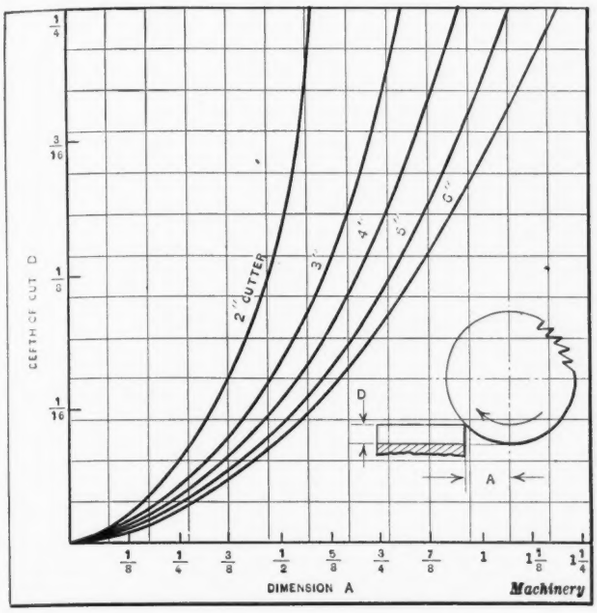


Chart for determining Length of Milling Cutter Travel

was developed to enable the production engineer to determine at a glance the distance *A* that a milling cutter must travel before it begins to take a full-depth cut. The curves plotted on the chart are for cutters ranging from 2 to 6 inches in diameter. By following the horizontal line opposite a figure or fraction indicating the depth of cut, to the point of intersection with one of the curves and then dropping a perpendicular line to the foot of the diagram, the dimension *A* can be read off directly.

Rochester, N. Y. BERNARD J. WOLFE

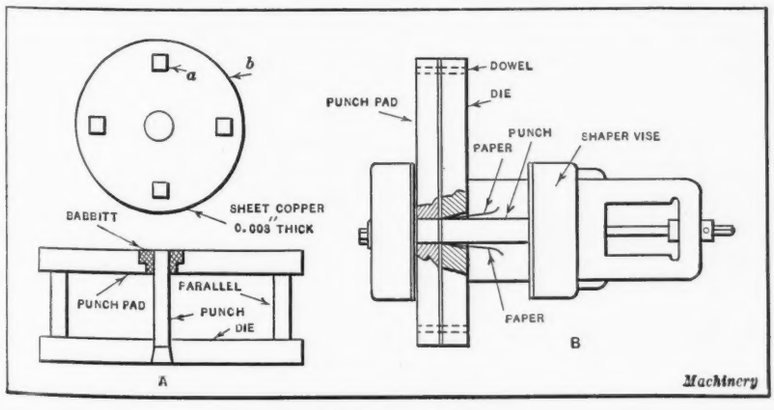
LINING UP PUNCHES

The method of lining up punches shown at *A* in the illustration has been used by the writer on dies for piercing sheet copper from 0.003 to 0.005 inch thick. No difficulty is experienced in lining up the round punches, as the holes in the die and the punch pad can be bored at one setting. The punches for the square holes *a* in the piece *b*, however, give considerable trouble, as they change their shape in hardening to such an extent that they are thrown out of line.

Drill rod stock 1/4 inch square was used for the punches employed to pierce the square holes in the blank *b*. The punches were not ground after being hardened. The square holes in the die were made a push fit for the punches. As the metal was thin, no allowance was left for clearance. The punch pad has a round, counterbored hole as shown. After all the punches and the die are hardened, the punches are set in place as shown, and babbitt metal poured around them. This method of locating and holding the punches in alignment with the die saves time and locates the punches accurately in line with the openings in the die.

At *B* is shown a method of making the holes come in line when the metal to be pierced is of heavy gage and the babbitt process cannot be used. First the holes are scribed on the punch pad through the die. Then the holes in the pad are filed to within about 0.003 inch of the scribed line, after which the two parts are doweled together as shown. The punches are hardened and ground square on both ends and are made to line up with the center of the die by using strips of paper as indicated. When thus positioned, the shaper vise jaws are tightened, causing the punches to shear through the punch pad. It is necessary to use the strips of paper to compensate for the clearance allowed between the punch and the die. This method, of course, is used only when the punches are not round and the die has two or more punches.

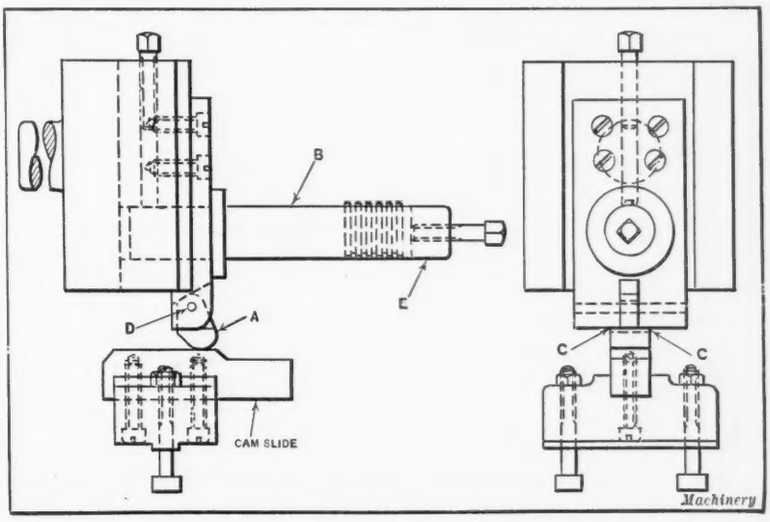
Philadelphia, Pa. CHARLES KUGLER



Method used in lining up Punches

INTERNAL THREADING ATTACHMENT

In the accompanying illustration is shown an internal threading attachment which was designed for cutting helical or thread-like oil-grooves in one of the bearings of a transmission case. The attachment was used on a Potter & Johnston machine, being secured to a standard vertical slide.



Attachment used in cutting Thread-like Oil-groove

On the slide is fastened a plate that holds the cam *A* and bar *B* in which six tool bits are clamped by the screw *E*. By using six tool bits, a good thread is completed in one cut. The cam *A* is so constructed that it is supported when advancing by the side wings at *C*, and is, therefore, held rigidly in position. On the return stroke, after the cut has been taken, the slide is pushed down by a spring to the lower position, so that the tool bits clear the work. The cam pivots on the pin *D* and thus permits the tool-holder to be withdrawn from the grooved hole in the transmission case.

Pontiac, Mich. H. KURZWEIL

SPIRAL GEAR DESIGNING KINK

In designing helical or "spiral" gears, the following kink will be found useful for determining the direction of the thrust on the bearings, the direction of shaft rotation, and the hand of the helix angle. First, cut out

two disks about 4 inches in diameter from heavy cardboard. Next, punch a hole in the center of each disk of a size that will give a fairly tight fit on an ordinary drawing pencil. Then, cut out two rectangular pieces of thin cardboard or heavy paper about 1/2 by 1 inch. With a knife, slit the edge of one disk at approximately the helix angle of the teeth of one of the gears to be designed. This slot should be about 1/4 inch deep. Then slot the other disk in the same manner, cutting the slot at the helix angle of the teeth in the other

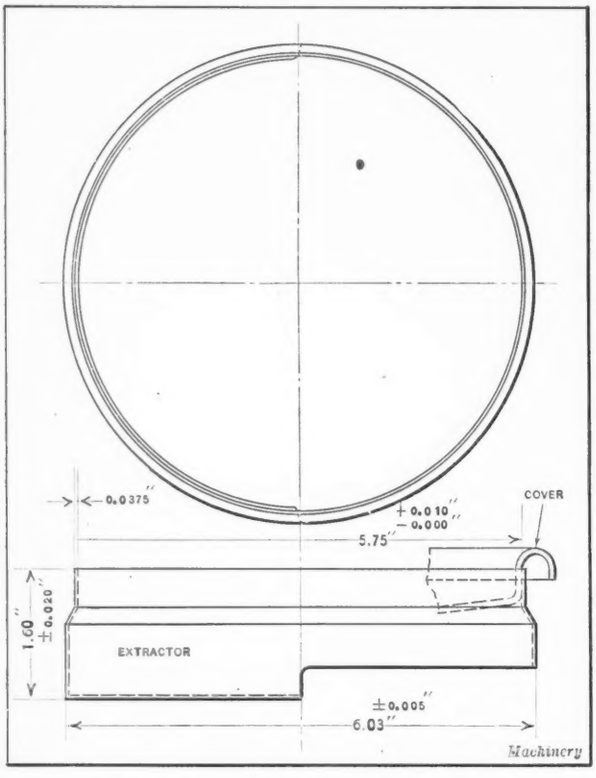


Fig. 1. Cover and Extractor for Cartridge Tank

gear. Place the rectangular pieces of cardboard in these slots, and mount the disks on two drawing pencils.

The pencils represent the two gear shafts, and the two pieces of thin cardboard represent one tooth on each gear. By holding the pencils at approximately the angle at which the gear shafts will be located in the finished design, and meshing the cardboard teeth, the direction of thrust, rotation, and "hand" of the helix angle can be clearly noted. The writer believes this method to be better than the usual method of drawing two gears on separate pieces of tracing cloth and then laying one over the other. The disks can be made as quickly as the drawings, and they can be used repeatedly until their edges are worn out or cut away.

Pensacola, Fla. FRANCIS M. WESTON

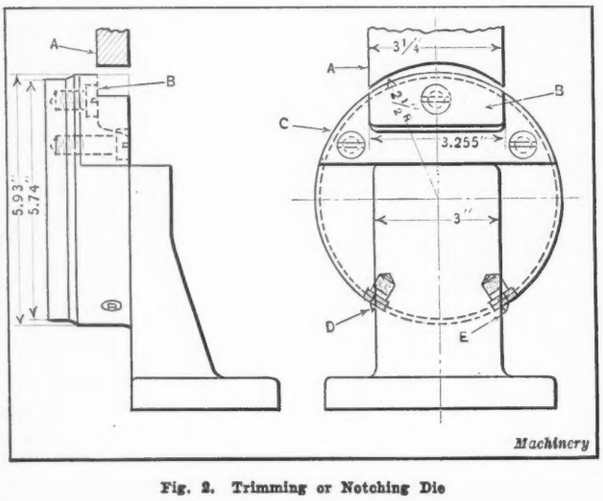


Fig. 2. Trimming or Notching Die

TRIMMING, FLANGING AND SPOT-WELDING SHELLS

In Fig. 1 are shown a cover and extractor for a cartridge tank. Both the extractor and cover are blanked and pressed or formed from sheet-metal stock. The extractor is first drawn into a pan shape, then notched or trimmed and flanged, after which the bottom is punched out. The extractor then becomes a ring instead of a pan, into which the cover is fitted and secured in place by spot-welding.

Fig. 3. Spot-welding Cover and Extractor

In Fig. 2 is shown the notching die on which the large end of the extractor is trimmed or notched to a depth of 1/2 inch for a total distance equivalent to one-half its circumference. The end *A* of the shearing tool is ground to a sharp edge, and shears the work as it passes the cutting edge of the lower shearing member *B*. The cast-iron frame *C*, in which the shearing blade *B* is held, is shaped to fit the cover. The extractor is put over the form or frame *C*, and the press set in operation. The notching operation is completed by turning the extractor around by hand. At *D* and *E* are shown stops that prevent the extractor from being notched for a distance greater than one-half its circumference.

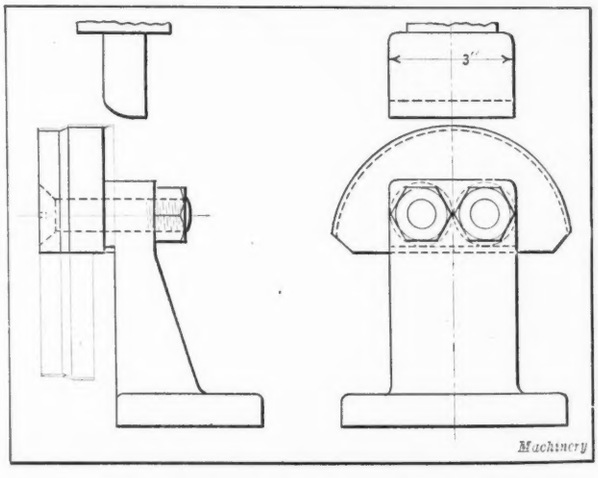


Fig. 4. Flanging Die for Extractor shown in Fig. 1

In Fig. 4 is shown the die used to flange or turn down the untrimmed edge of the extractor to an angle of 90 degrees. After the extractor has been completed, the cover is inserted in the small end and spot-welded with the equipment shown in Fig. 3. Spot-welds are made at eight evenly spaced points. The work is held by hand while one of the electrodes *A*, Fig. 3, which is secured in the holder *B*, is brought into contact with the work to be welded.

Portsmouth, Va. R. S. MORECOCK

SAFETY DEVICES FOR SHEET-METAL WORK

There are many ways in which injuries may be received when working sheet metal, and it is impossible to devise means for making all of the many processes safe, yet there are some instances in which a simple device will greatly

lessen the danger of injury to the workman or to those near him. Two devices of this nature are illustrated and described in this article.

In Fig. 1 is shown a safety device employed while chipping off the edges of a sheet-metal piece to make it conform roughly to the finished contour. The danger in performing this work is from the flying pieces. These pieces do not endanger the operator himself as much as they do the workmen around him. The protective device consists of a lid or deflecting plate *A* secured to the chipping block *B* by two machine screws, one of which is shown at *C*. After the deflecting plate has been adjusted to such a position that it will stop the flying pieces, it is clamped in place by tightening the screws *C*. When the chipping block is not in use, the plate *A* can be folded down in contact with the chipping block so that the complete device will occupy but little space.

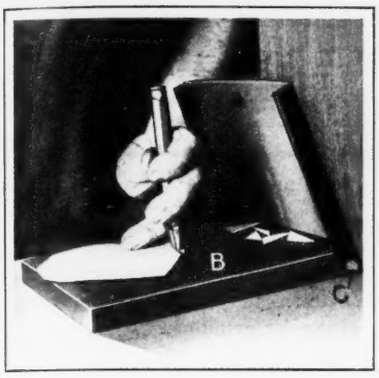


Fig. 1. Chipping Block with Guard Lid

In Fig. 2 is shown a convenient tool for flattening out sheet-metal pieces that have been bent while being chipped or cut to shape. Ordinarily, a hammer is used for this work, but as it strikes only a small portion of the metal at one blow, it is necessary to hold the work firmly in place with the fingers. Often when the bent piece is struck a sharp blow with a hammer, it will jump or spring up with sufficient force to bruise the fingers. Sometimes a piece twists sidewise in such a manner as to cut the operator's fingers. By using the tool shown, the sheet metal can be held down firmly against the block without danger of injury to the workman's hands. A cross-pin is provided in the tool to facilitate lifting it.

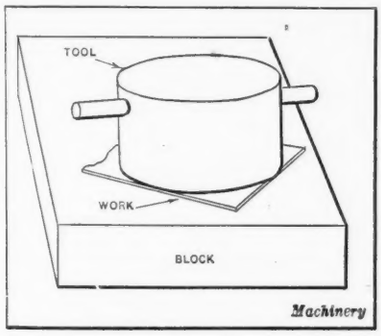


Fig. 2. Tool for flattening Sheet Metal

Rosemount, Montreal, Canada HARRY MOORE

TESTING GAGES FOR SPRINGS

Three tension springs like the one shown at *S*, Fig. 1, were required in the manufacture of a trigger type electric switch. These springs were 1 5/32 inches long, and 1/4 inch outside diameter. They were made from music wire 0.034 inch in diameter and were required to elongate 1/32 inch under a load of two pounds. In the production of the first few hundred switches, a great variation in the tension of the springs was noted, although they were produced on automatic machines. The variation was not only noticeable in the operation of the trigger itself, but the excess tension often caused mechanical failures by producing undue shock and wear. In order to avoid troubles of this kind, it was decided to make tests to establish certain manufacturing limits for the tension or pressure exerted by the springs.

Owing to the small variation in tension allowed, it was necessary to construct the very sensitive gage shown in Fig. 1, for inspecting the finished springs. This testing device was found to be very rapid, the inspector only having to lift the beam with his right hand and engage the spring first with arm *A* and then with pin *B*, after which he simply recorded the indicator reading at point *C*. Although only about 15 per cent of the springs tested were rejected, variations in tension of 30 per cent were often noted.

In another case, it was found necessary to establish limits for a flat leaf spring, such as shown at *A*, Fig. 2. Four leaves were used in making up a complete spring or unit. These springs were 5 15/16 inches long and 2 3/8 inches wide, and were made from Swedish spring steel 1/16 inch thick. After being blanked, they were annealed and flattened with a flat-faced hammer. Rounding the edges and then heat-treating completed the springs. In order to reduce the cost of the testing fixture, a regular weighing scale *B*, with a range of from 0 to 300 pounds, was incorporated in the design. The scale was mounted in the cast-iron frame *C*. The scale platform was removed and replaced by the platform *D* on which was mounted the indicator attachment.

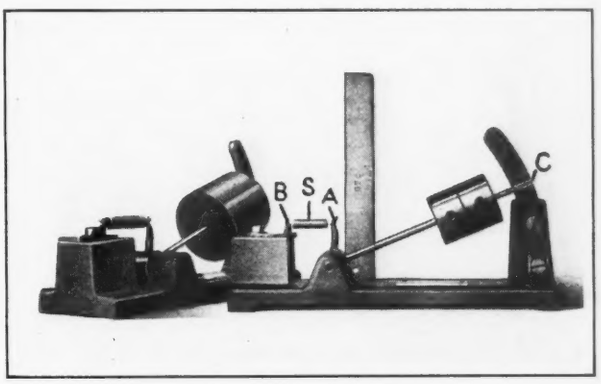


Fig. 1. Coil Spring Testing Gage

The contact point of this attachment engages the under side of the spring *F* being tested, at a point directly under the cam *G*.

The amount the springs are deflected is indicated on the scale *H*, by indicator *L*, and the pressure, in pounds, required to obtain a given deflection is indicated by the scale *B*. The four leaves of the spring to be tested are placed on the retainer, after which the indicator plate is adjusted by means of the screw *K* until the indicator point *L* falls on the lower line of scale *H*. Each division on the scale represents 1/32 inch actual compression of the springs.

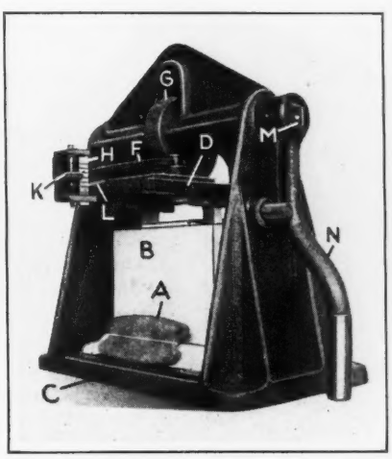


Fig. 2. Leaf Spring Testing Gage

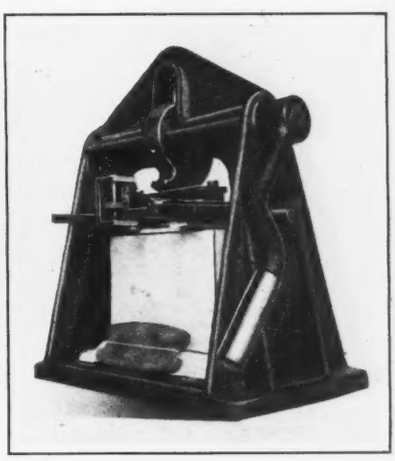


Fig. 3. Gage with Spring compressed

The compressing cam *G* is rotated by means of shaft *M* and handle *N* to the position indicated in Fig. 3, at which point the required compression of the springs is obtained as noted on the scale *H*. The reading in pounds is then taken directly from scale *B*. In designing a testing device of this kind, care must be taken in laying out the cam to make allowance for the movement of the scale platform, which, in the case of the scale shown, was 0.0035 inch per pound. The use of the testing device described reduced spring failure to a very small amount and served as a check on both the material and the heat-treating operation. The springs were tested and tied together, four in a set, at the rate of 75 sets per hour. In checking up the accuracy of the device, it was found that the formula for the safe load and deflection on page 450 of the sixth revised edition of MACHINERY'S HANDBOOK gave values that agreed with the results obtained.

Pittsburg, Pa. GEORGE T. CHAPMAN

MANDREL FOR HOLDING ANGLE MILLS WHILE SHARPENING

The chief advantage of the cutter-holding mandrel shown in the accompanying illustrations is that there is no risk of scoring a good arbor, as the conical collar and screw-holding arrangement allow the wheel to be passed clear by

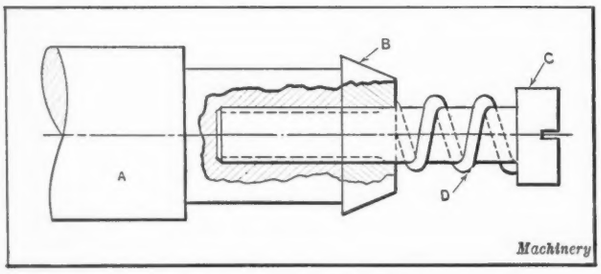


Fig. 1. Arbor for holding Milling Cutter

the work, which cannot be done when the work is held between centers. The device is also more compact and easier to manipulate and is more convenient to set for the extreme angular positions often required by steep-angle cutters.

The mandrel body *A*, Fig. 1, has a shank somewhat larger than the hole in the cutter, which forms a shoulder against which the cutter is held. The conical-shaped collar *B* serves to retain the cutter against the mandrel shoulder, being held in place by screw *C* and coil spring *D*. The mandrel is held in the regular angular fixture customarily supplied with cutter and tool grinders, the fixture being set at the

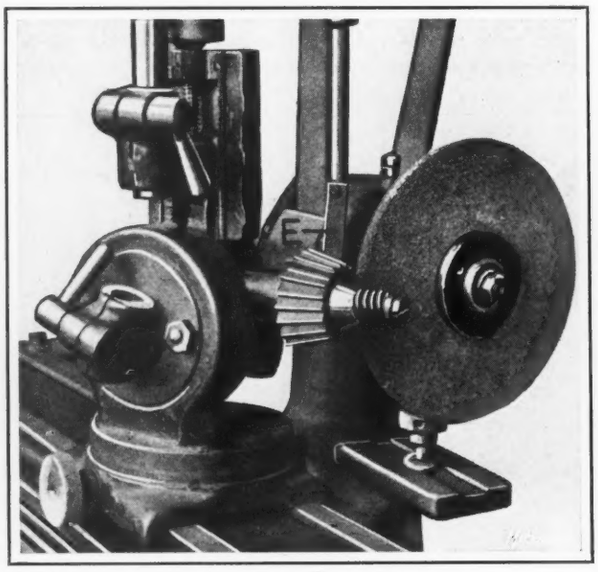


Fig. 2. Grinding Angle Mill

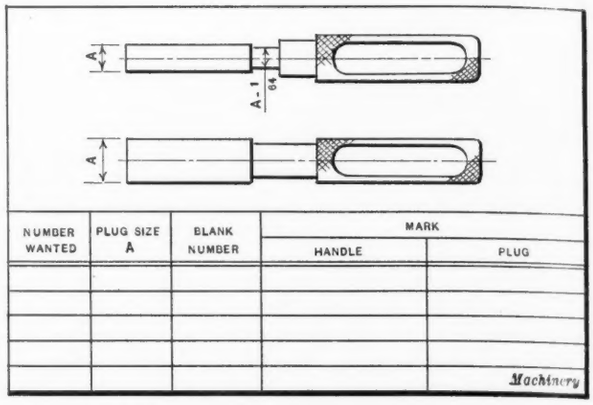


Fig. 1. Printed Form for Finish Dimensions of Stock Plug Gages

proper angle. The finger *E*, Fig. 2, which engages the lip of the flute being sharpened is a part of the regular fixture. The spring tension by which the cutter is held on the mandrel permits rotating the cutter readily to bring the different flutes into the proper position for grinding.

Springfield, Vt. O. S. MARSHALL

DRAWINGS FOR SEMI-STANDARDIZED PARTS

Considerable time can be saved in drafting-rooms by using printed forms or charts in place of drawings for semi-standardized parts, such as the common types of plug, ring, or snap gages. These printed forms or charts may have various details with blank spaces in which the special dimensions or sizes can be inserted. In Fig. 1 is shown a suitable chart for plug gages, while in Fig. 2 is shown a form or master drawing for a formed plate that is made in different lengths. The two types of plug gages shown in Fig. 1 are carried in stock in a semi-finished condition, and the

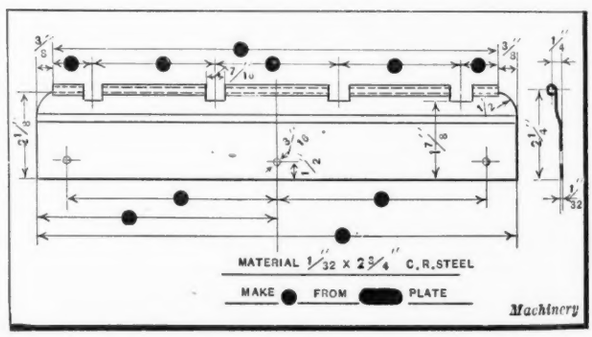


Fig. 2. Master Type of Tracing for Semi-standardized Part

designer simply fills in the required sizes on the chart, the stock gages being finished to these sizes by the workman to whom the order is given.

The style of master drawing shown in Fig. 2 is used for making blueprints on which the special dimensions can be filled in with pencil or ink. The black circles on the tracing leave white blank spaces on the blueprint on which the required dimensions are placed.

Holyoke, Mass. FRANK H. MAYOH

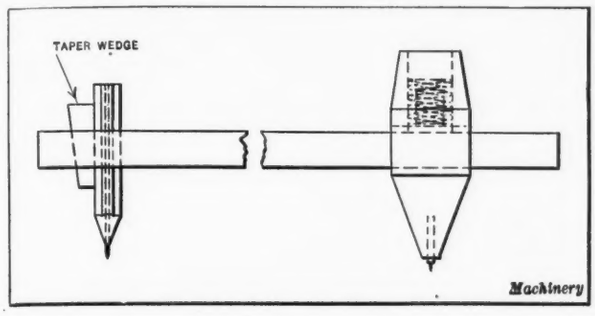
* * *

The Oil and Gas Power Division of the American Society of Mechanical Engineers, in a paper contributed to *Mechanical Engineering*, calls attention to the fact that the greatest problem in the application of oil engines to locomotive driving is not in the design of the engine itself, but in the mechanism for transmitting the engine power to the locomotive drivers. The electric drive meets the demand for high starting torque and ease of control, but is objectionable on account of its weight. For these reasons, efforts are being made to find improved forms or types of transmission.

Shop and Drafting-room Kinks

EASILY CONSTRUCTED BEAM COMPASS

In the accompanying illustration is shown a beam compass employed in a plant engaged in the manufacture of cooperage machinery. Although practically the entire compass is made of wood and is easy to construct, it is accurate and



Beam Compass of Simple Design

can be quickly adjusted. With the usual type of beam compass, adjustment of the pen, pencil, or bearing points, is made by releasing a screw, adjusting the points to the distance required, and then retightening the screw. This operation consumes an appreciable amount of time.

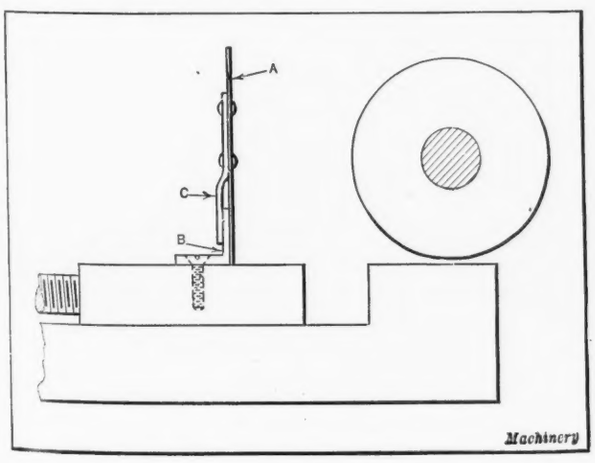
With the compass shown in the illustration, however, no screws are used for either holding or releasing the points. Instead, the bearing point holder is made a sliding fit over the beam and is held in position by a friction grip obtained by means of a small coil spring placed inside the point holder. This spring maintains a constant pressure on the beam, which is sufficient to hold the point rigid and immovable under ordinary working conditions. When an adjustment for distance is required, the draftsman simply moves the point holder along the beam with his hand until the required position or adjustment is obtained.

A beam compass of the type described is particularly adapted for use in the drawing-room when quick work is desired on preliminary drawings or sketches.

Buffalo, N. Y. ARTHUR L. GREENE

COOLANT SPLASH PLATE FOR MILLING MACHINE

A light manufacturing milling job on a hand miller was made much more agreeable for the workman by providing a guard or splash plate such as shown at *A* in the illustration.



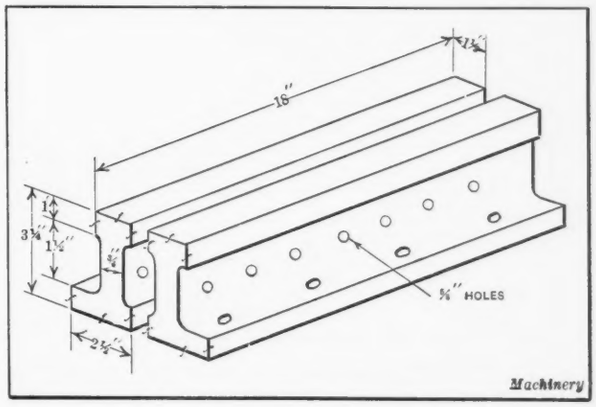
Splash Plate attached to Milling Machine Vise

This plate prevented the coolant from being thrown on the work-holding vise. As stops were provided for the table, it was unnecessary for the operator to see either the cutter or the work while taking a cut. A piece of light angle-iron *B* was secured to the movable jaw of the vise, far enough back to clear the cutter. The splash plate *A* was made from a piece of 1/32-inch sheet metal. On the back of this plate two pieces of strip steel *C* were fitted after being bent to shape. The plate thus formed was clipped over the upright side of the angle-iron. The plate can be removed when setting up work or when, for any other reason, it is necessary to have free access to the cutters or work.

Middletown, N. Y. DONALD A. HAMPSON

LARGE PARALLELS FOR GENERAL SHOP USE

Several sets of large parallels like those shown in the illustration are valuable aids in setting up heavy jobs on milling, planing, or boring machines. The set shown is designed primarily for rough usage, and is made as light as possible, consistent with the heavy work for which it is in-



Parallels for General Shop Use

tended. A series of drilled holes makes the parallels easily adaptable for many jobs for which ordinary parallels are not intended, such as bolting in vertical and angular positions without the use of clamps. The holes also add to their lightness and convenience in handling. The dimensions shown may, of course, be modified to suit requirements. Kept in convenient locations about the shops or in the tool racks near the machines, parallels of this type will soon pay for their cost in time saved.

Springfield, Vt. H. L. WHEELER

* * *

ACCIDENT RECORDS

A report containing accounts of breakdowns and failures of steam engines, oil engines, boilers, electrical equipment, etc., selected from the casualty list of the year because of the possible value these accounts would have to manufacturers and users of the various kinds of machinery covered, has been prepared by the chief engineer of the British Engine, Boiler, and Electrical Insurance Co., Ltd. Each accident is reported in detail, with drawings, photographs, photomicrographs, etc., and the evidence is closely analyzed to bring out the cause. It is suggested in *Mechanical Engineering* that a report covering similar classes of accidents in this country would doubtless accomplish much in preventing accidents of this kind and improving the design of power equipment.

Questions and Answers

FORMULA FOR PROPORTIONING BOX DIMENSIONS

J. E. H.—From a rectangular blank, four corners are to be notched out, as indicated by the dotted lines in the illustration. The notched blank is then made into a box or pan of the shape indicated by the heavy lines, by bending up the ends and sides. A box of maximum capacity will be obtained only when the corners are notched to a certain depth. Will some reader kindly give a formula for determining the dimension x which will give a box of maximum capacity?

ANSWERED BY B. SPECTOR, SHARON, PA.

Having given a rectangular blank with the length indicated by dimension a and the width by dimension b, we

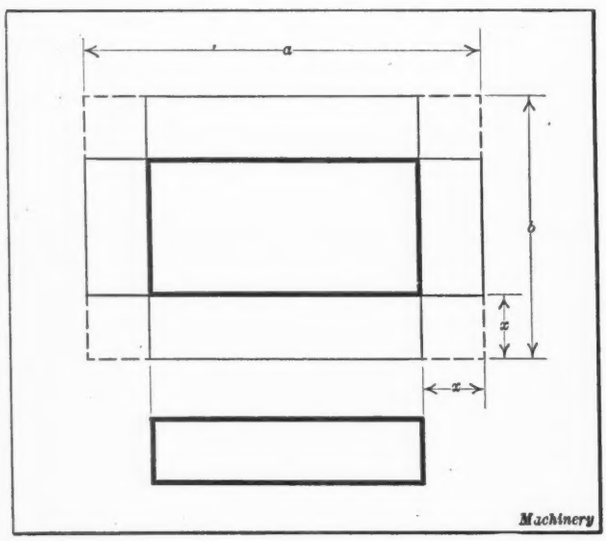


Diagram showing method of notching Box Blank

can determine the size of the notch to be made in each corner that will result in a box having the maximum cubical contents by employing the formula,

$$x = \frac{a + b \pm \sqrt{(a+b)^2 - 3ab}}{6}$$

For example, if $a = 15$ inches and $b = 8$ inches, we have,

$$x = \frac{15 + 8 - \sqrt{(15+8)^2 - 3 \times 15 \times 8}}{6}$$

$$= \frac{10}{6} \text{ or } 1\frac{2}{3} \text{ inches}$$

* * *

GRINDING WHEEL BUSHINGS

A. S.—What metal or alloy is used for the bushings of grinding wheels? Should the bushing fit the spindle tightly or have a slight clearance?

A.—Most grinding wheels are bushed to size with lead, babbitt, or some other soft material, the exception being very small wheels, or very large wheels that are to be held in a chuck or in some way other than by flanges on a spindle. The bushing process follows that of truing. The bushing must be true with the sides of the wheel; otherwise, the wheel may break when placed on the spindle and the flanges tightened. The diameter of the hole should be from 0.002 to 0.005 inch larger than the diameter of the spindle on which the wheel is to be mounted. If the hole is smaller, breakage may occur by forcing the wheel. If the hole is larger than this limit, it is difficult to mount the wheel so that it will run true and straight, and, too, it may be clamped in the flanges in such a position as to be out of balance. Lead is the most commonly used material for bushings. Babbitt, being a little harder, is better for the severe duty to which coarse wheels and large cup-wheels are subjected. If the lead is too soft, the bushing will not retain its shape and will be easily damaged when the wheel is mounted.

* * *

DIAMETRAL OR DIAMETRICAL PITCH?

W. G. C.—Which is the correct expression, "diametral pitch" or "diametrical pitch?"

A.—The expression "diametral pitch" is found in practically all handbooks, reference works, and text-books on gearing, and may therefore be considered as sanctioned by common usage; hence, it may be assumed that this is the correct expression. The dictionaries do not wholly agree on the subject, and the common usage in the mechanical field, therefore, should govern.

Webster's New International Dictionary defines diametral (pronounced *di-am'-e-tral)* pitch under the word "diametral." Under "diametrical" it says, "Diametrical pitch, diametral pitch." According to Webster's dictionary, therefore, "diametral pitch" is preferred.

The Century Dictionary defines diametral as "pertaining to a diameter; diametrical;" and diametrical as "of or pertaining to a diameter; along a diameter; diametral." This dictionary, therefore, makes no distinction between the meaning of the two words.

Funk & Wagnall's Dictionary, again, defines diametrical as "of or pertaining to a diameter;" and diametral as "of or pertaining to the ends of a diameter, directly opposite and as far removed as possible; irreconcilable." Were we to take the authority of this dictionary alone, therefore, we would assume diametrical to be the correct term.

* * *

POWER EQUIVALENTS

C. A. H.—In MACHINERY'S HANDBOOK (page 1553 revised edition) under "Power and Heat Equivalents," 1 horsepower-hour has an equivalent of 2.64 pounds of water evaporated at 212 degrees F. How does this check with the usual equivalent of 34.5 pounds of water evaporated at 212 degrees F.?

A.—The horsepower-hour equivalent is correct as given in MACHINERY'S HANDBOOK. Your reference to the evaporation of 34.5 pounds of water at 212 degrees F. indicates that you have confused the method of rating boilers with the horsepower-hour equivalent, since the evaporation of 34.5 pounds of water from a feed water temperature of 212 degrees F. into steam at the same temperature is commonly accepted as the equivalent of a boiler horsepower. This, however, differs from the equivalent of a horsepower-hour.

A horsepower-hour equals $33{,}000 \times 60 = 1{,}980{,}000$ foot-pounds. Now from careful experiments it has been found that one unit of heat or one British thermal unit is equivalent to 778 foot-pounds of work. Moreover, the changing of one pound of water at 212 degrees F. into steam at that temperature will require about 966 British thermal units, or $966 \times 778 = 751{,}600$ foot-pounds nearly. This being the case, it is evident that the number of pounds of water evaporated at 212 degrees F., which represent one horsepower-hour, equals $1{,}980{,}000 \div 751{,}600 = 2.64$ pounds of water, as given in MACHINERY'S HANDBOOK.

HEALD MACHINE COMPANY ONE HUNDRED YEARS OLD

One hundred years have passed since Stephen Heald started the machine business which is now well known under the name of the Heald Machine Co. This business was started in 1826 in what is known as Heald Village, Barre, Mass. In its earliest days, it was a jobbing shop, but later woodworking machinery, agricultural equipment, and wire-drawing machinery were manufactured. An iron foundry was established in connection with the machine business in the early fifties. This was the only foundry in the vicinity at that time. Coal and iron had to be hauled twenty-five miles from the nearest railroad.

In 1890, after the death of Stephen Heald, the business was carried on by his son Leander S. Heald and his grandson James N. Heald, the name of the firm at that time being L. S. Heald & Son. It was about this time that the owners of the business became vitally interested in the manufacture of grinding machines, including drill grinders, center grinders, and miscellaneous grinding attachments. In 1903, in order to broaden this line, it was deemed desirable to move to a more central location having better labor supply and shop facilities. At this time James N. Heald, the present head of the business, bought out his father's interest and organized the Heald Machine Co., the business at that time being moved to Worcester. Two sons of James N. Heald, Richard A. and Roger N., are now also connected with the company.

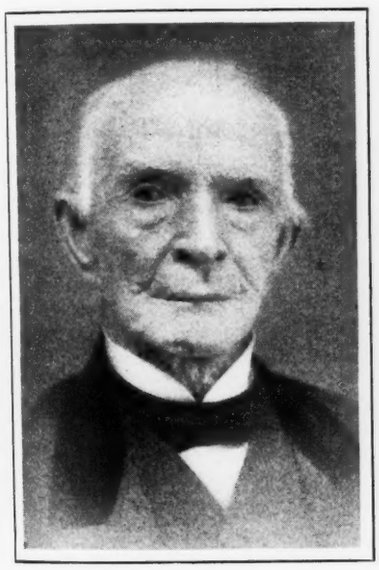
A ring and surface grinder, followed shortly by a cylinder grinder, were the next machines to be placed on the market. Later the company brought out a line of internal grinding machines built for quantity production. These differed from the cylinder grinding machines in that the latter were designed for large parts that could not be revolved, while the internal grinder handled bushings, ball races, gears, etc., that could be readily chucked for grinding the hole. Mechanical readers are familiar with the most recent advances that have been made in the Heald line of machines—the application of the hydraulic oil drive, and the development of semi- and full-automatic internal grinding machines.

When the business was first moved to Worcester in 1903, a shop, 90 by 100 feet, was occupied, having 21 employes. The present plant is 200 by 600 feet and employs, normally, 600 men, additions having been made to the buildings in 1907, 1909, 1911, 1914, and 1917.

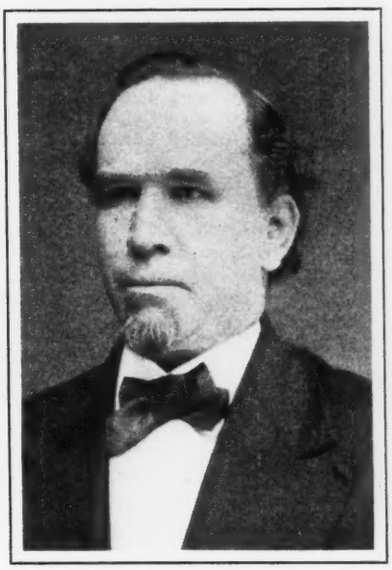
In commemoration of the one-hundredth anniversary, the Heald Machine Co. held a celebration in Worcester January 7, which is the first date inscribed in the first ledger of the Heald business. On the anniversary day, the shop was closed at 3 o'clock, and the employes assembled. James Heald gave a talk on the history of the business and its growth from a modest beginning to the development of the present organization. At this time he also presented gold watches to twelve men who have completed fifteen years of service, and a purse of gold to six men who have completed twenty years of service. The employes, in turn, presented Mr. Heald with a bronze tablet commemorating the anniversary and containing the following inscription: "To James N. Heald from the employes of the Heald Machine Co., on the occasion of the one-hundredth anniversary of the establishment of the business. Given as a testimonial to his high sense of honor and fairness, and as a tribute of their loyalty and affection. January 7, 1826—January 7, 1926."

At the bottom, in bold relief, is shown the old shop and foundry at Barre. On the side forming the frieze is an oak tree, and in the branches in bold relief is shown the present shop, carrying out the idea that "great oaks from little acorns grow."

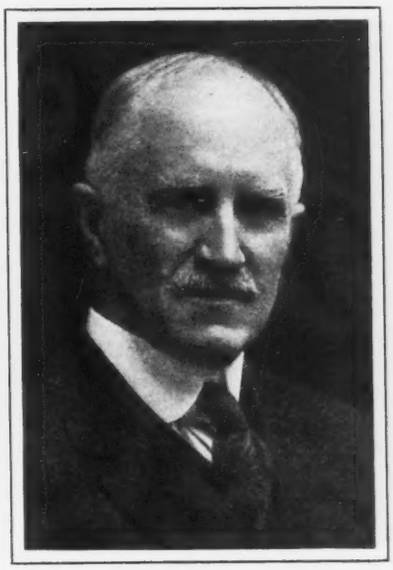
The Heald Machine Co. has also issued an anniversary publication called "The First Ledger," containing a general history of the business and facsimile reproductions of the first ledger of 1826. Perhaps the most noticeable difference in this ledger, as compared with modern bookkeeping, is that in balancing the accounts, goods and food products were almost invariably accepted for payment. In fact, currency was used only in very rare cases. A specific value in currency, however, was entered opposite the entries listing the products received in payment.



Stephen Heald



Leander S. Heald



James N. Heald

* * *

MEETING OF MANAGEMENT ASSOCIATION

At the annual convention of the American Management Association to be held at the Hotel Astor, New York City, March 3 to 5, a great many subjects will be discussed, among which may be mentioned the line executive's part in training, rating employes, budgeting man power, employe investments in company securities, principles underlying vacations, keeping down the cost of company publications, setting up a forecasting program, part-time education, the penalties of irregular business, the changing status of the worker, labor banks and insurance companies, building and loan associations, credit unions, employe bank savings plans, how to help the employe work out his own insurance program, rating office employes, the office supervisor's part in training, meeting and minimizing peaks in office work, rating manual workers, the foreman's part in training, planning, and maintaining a regular flow of work, rating salesmen, the sales supervisor's part in training, and marketing policies and sales methods.

CARBURIZING AND HEAT-TREATING CAMSHAFTS

The recommended practice given here for carburizing and heat-treating camshafts is a tentative recommended practice approved by the Recommended Practice Committee of the American Society for Steel Treating and will remain tentative until such time as it is adopted by the Recommended Practice Committee and the board of directors of the society. The chemical composition of steels that may be used for camshafts is given in Table 1, and the practice presented here is not applicable to steels of any chemical composition other than those specified in the table.

Annealing and Heat-treating after Forging and before Machining

For annealing the S. A. E. steels 1015, 1020, 2320, 3120, 6120, and the 0.50 per cent nickel, nickel-molybdenum, and the chromium-vanadium steels, the steel is placed in the furnace in such a manner as to expose the maximum amount of surface or area. The work is then heated slowly and uniformly to a temperature of 1600 to 1650 degrees F., and cooled at a rate that will give the desired machineability.

For annealing the 5 per cent nickel steel—S. A. E. 2512—the steel is placed in the furnace in such a manner as to expose the maximum surface or area. It is heated slowly and uniformly to 1600 degrees F., and held at this temperature for about one hour. The steel is then cooled slowly in the furnace to a temperature of 800 degrees F., after which it is cooled in air. Before machining hollow camshafts, they should be quenched and tempered at the proper temperatures to give the desired machineability.

Two methods are commonly used for obtaining accurate camshafts with hardened surfaces only at such points as the service requires. In one method, the entire shaft is copper-plated before being carburized, and the copper is removed, by grinding or turning, from those surfaces that are to be carburized and hardened. The second method consists of forging or machining the camshafts to a somewhat larger size, with an excess of metal between the cams and bearings. The excess metal is then machined off after carburizing and before hardening.

Carburizing Camshafts

The carburizing operation should be carried out in containers and furnaces of suitable dimensions and design to permit uniform heating. The carburizing temperatures for the various steels are given in Table 2. The camshaft should be so packed that the areas to be hardened do not come in contact with each other or with the walls of the containers. Sufficient compound should be used to prevent the camshafts from being exposed at any time during the carburizing and cooling operations. After carburizing, the camshafts are allowed to cool in the containers.

The time required to give the depth of case required depends upon a number of factors, such as temperature of the furnace at the time of loading, rate of heating, type of furnace, thickness of the containers, amount of stock left for grinding, etc. However, the carburizing time and the amount of stock left before grinding should be so regulated that the depth of case, after grinding, is at least 0.045 inch. The hardness of the camshaft should not be less than that shown by a scleroscope reading of 75.

Heat-treatment of Camshafts after Carburizing

In hardening, the camshafts should be heated uniformly to the temperature given in Table 2, and this heat main-

TABLE 1. CHEMICAL COMPOSITION OF STEELS USED FOR CAMSHAFTS

Kind of Steel	Carbon		Manganese		Phosphorus	Sulphur	Nickel		Chromium		Molybdenum		Vanadium	
	Min.	Max.	Min.	Max.	Max.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
S.A.E. 1015	0.10	0.20	0.30	0.60	0.045	0.050	....	....	....	....	....	....	....	....
S.A.E. 1020*	0.15	0.25	0.30	0.60	0.045	0.050	....	....	....	....	....	....	....	....
S.A.E. 2320	0.15	0.25	0.50	0.80	0.040	0.045	3.25	3.75	....	....	....	....	....	....
1/2 Per Cent Nickel	0.10	0.20	0.30	0.60	0.045	0.050	0.50	0.75	....	....	....	....	....	....
S.A.E. 2512	0.17	Max.	0.30	0.60	0.040	0.045	4.50	5.25	....	....	....	....	....	....
S.A.E. 3120	0.15	0.25	0.30	0.60	0.040	0.045	1.00	1.50	0.45	0.75	....	....	....	....
Ni-Mo	0.10	0.20	0.30	0.50	0.040	0.045	1.25	1.75	....	....	0.20	0.30	....	....
S.A.E. 6120	0.15	0.25	0.50	0.80	0.040	0.040	....	....	0.80	1.10	....	....	0.15	0.20
Cr-V*	0.10	0.15	0.30	0.50	0.040	0.040	....	....	0.25	0.40	....	....	0.15	0.20

Machinery

*These steels are the ones most commonly used for camshafts.

TABLE 2. DATA FOR CARBURIZING AND HEAT-TREATING CAMSHAFTS

Kind of Steel	Carburizing Temperature, Degrees F.		Where Cooled	Reheating Temperature, Degrees F.		Quenching Bath	Tempering Temperature, Degrees F.	
	Min.	Max.		Min.	Max.		Min.	Max.
S.A.E. 1015	1625	1715	Box	1425	1450*	Water or Brine	350	400
S.A.E. 1020	1625	1750	Box	1425	1450*	Water or Brine	350	400
1/2 Per Cent Nickel	1650	1700	Box	1375	1425*	Water or Oil	250	450
S.A.E. 2320	1575	1625	Box	1325	1375*	Oil	250	450
S.A.E. 3120	1625	1675	Box	1375	1425*	Water or Oil	250	450
S.A.E. 2512†	1600	1650	Box	1350	1400*	Oil	250	450
Ni-Mo	1650	....	Box	1475	1525	Oil	350	....
S.A.E. 6120	1675	1725	Box	1425	1475*	Water or Brine	400	450
Cr-V	1675	1725	Box	1425	1475*	Water or Brine	400	450

Machinery

*Use lowest possible temperature to produce maximum hardness.
†After rough-machining, anneal at 1450 degrees F., air cool, finish the machining, and then carburize.

tained to insure complete penetration. The heating medium should be of such a type that no carburization will take place. To prevent warpage, the shaft should be arranged properly in the heating medium, and quenched vertically or else rolled horizontally into the quenching bath.

Tempering

After quenching, the camshaft should be reheated in a suitable medium to the temperature given in Table 2, and held at this heat for at least one hour in order to insure complete penetration of the heat. The highest temperature that will not affect the hardness should be used.

Any one of several methods may be used for packing the camshafts. For example, a single shaft may be packed in a tube or a number of shafts may be packed in a tube or box of suitable size. The majority of methods give good results if properly carried out. In using the plain carbon steel (S. A. E. 1020), satisfactory results may be obtained without annealing or otherwise heat-treating before machining, although the steel can be brought into a better condition by annealing or other proper heat-treatment. When a salt bath is used as a heating medium for hardening, the shafts are sometimes preheated at a temperature of approximately 600 degrees F., and then transferred to the salt bath, in which they are suspended vertically to prevent warping; they are kept in the heating medium until they reach the proper hardening temperature, and are then quenched and tempered.

* * *

INDUSTRIAL STANDARDIZATION IN 1925

By C. E. SKINNER, Chairman, American Engineering Standards Committee

Important developments in the growth of the industrial standardization movement took place in 1925. One of the most important of these was the increase of active interest on the part of industrial executives. A conference of leading executives, held early in the year, organized a committee from their own numbers to serve as an advisory committee to the American Engineering Standards Committee, and these men are now giving time and assistance to the solving of national standardization problems.

Of special interest to the factory owner and manager is the Directory of Specifications, published in August, 1925, by the Department of Commerce. This compilation lists approximately 27,000 existing specifications covering 6000 commodities, and will be found very useful in connection with purchases. The astonishing multiplicity of specifications on the same subject brought forward the problem of unifying them into consistent groups.

The list of projects now before the American Engineering Standards Committee, at various stages of development, totals 218, including 76 approved standards. Notable progress has been made during 1925 in the completion or further development of many of these projects. The number of projects of each industry, represented in this work by 250 national organizations, is as follows: Civil engineering and the building trades, 35; mechanical engineering, 63; electrical engineering, 32; automotive, 4; transportation, 9; shipbuilding, 1; ferrous metallurgy, 9; non-ferrous metallurgy, 15; chemical industry, 12; textile industry, 3; mining, 16; wood industry, 5; pulp and paper industry, 1; miscellaneous, 13.

In the field of mechanical engineering, a system of limit gaging, together with a comprehensive scheme of fits, which is probably the most important project ever carried through by the American Engineering Standards Committee, lays the basis for the carrying out of complete interchangeable manufacture on a national scale, as well as for facilitating mass production within the individual factory. When this work permeates the structure of American manufacturing industry, the resulting savings will run into enormous figures. Two dimensional standards, dealing with cold-finished shafting and square and flat shafting keys, have also been approved.

At a conference held in December, a comprehensive program for the standardization of drafting-room practice was launched. There has been great interest in this subject, and it bids fair to become a matter of first importance on account of the wide range of industries that it affects. Although many individual factories have already worked on the standardization of drafting-room practice, we are on the whole far behind European countries in bringing about the economies possible through national standards.

In the electrical field, the 1925 edition of the national electrical code has been approved, as well as a system of connections and markings for electric power apparatus. A standard for instrument transformers has been recommended for approval, and a standard for synchronous converters has also been submitted. For the first time, complete national agreement has been reached on a safety code for aeronautics. The code deals with standards of safety for design, construction, testing, and operation of aircraft. Good progress has been made in the code for automobile brakes and brake testing. The mining industry is the most recent of the great industries to take up standardization on a comprehensive scale. In addition to the sixteen standardization projects now under way, three more have been officially proposed. A notable step in the prevention of mine explosions has been the completion of a code for rock dusting of coal mines.

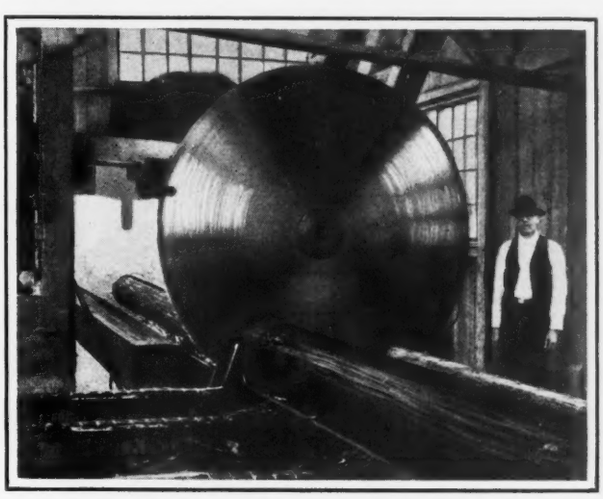
In the field of industrial safety, satisfactory progress has been made on a program of some forty codes, most of which are applicable to factories. Seventeen of these have been completed, and work on the remainder is well advanced.

Standardization on an international scale is still in its infancy; yet through the cooperation of the various national standardizing bodies there has been real progress in several subjects. Of special interest, on account of its relation to the use of specifications in the development of foreign trade, is the First Pan-American Conference on the Uniformity of Specifications, which was held in the first part of January, 1925, in Lima, Peru. It was decided to hold another such conference in the United States within a year or two. In connection with the meeting of the International Electrotechnical Commission which is to be held in New York in April, 1926, there will also be held in New York a conference of the chairmen and secretaries of the national standardizing bodies, for which the American Engineering Standards Committee will act as host.

* * *

SAW 110 INCHES IN DIAMETER

What is believed to be the largest circular saw in the world is shown in the accompanying illustration, sawing up logs. This saw is 110 inches in diameter, and is driven at a rim speed of approximately 10,000 feet per minute. Logs up to 40 inches in diameter are sawed into various lengths, and one cut is averaged every fifty seconds. Instead of the saw being mounted in the customary manner, it is suspended above the log and drawn back and forth across it. The saw weighs 675 pounds, and is driven by a 50-horsepower motor. It was made by Henry Disston & Sons, Inc., Philadelphia, Pa.



Large Circular Saw drawn back and forth across the Work

DRAWING-ROOM PRACTICE TO BE STANDARDIZED

The American Engineering Standards Committee announces the launching of a comprehensive program of standardization of drafting-room practice. This action follows the unanimous recommendations of a representative conference held in December, which was attended by fifty individuals, representing forty-eight professional and trade associations, engineering schools, and manufacturing concerns.

Doing away with the diversity in drafting-room practice and in the materials, equipment, and tools used for making drawings will result in a more ready understanding of drawings by anybody for whom they are intended, in great savings in the draftsman's time and efforts, and in a more efficient use of drafting materials and filing cabinets for the storage of completed drawings. One of the important items is, for example, the series of sizes for drawings. If these can be standardized, it will not only be possible to utilize drawing paper and tracing cloth as it comes in rolls or sheets, to the greatest advantage; but it will also be possible to supply the drafting department with sheets cut to size in advance, on which the border line and the several spaces for title, the part list, etc., have been printed.

Besides the question of drawing sizes, the program adopted by the conference contains mainly the following items: Classification of and corresponding nomenclature for drawings in accordance with their purpose; method of representation of the subject, as, for example, the arrangement of views and sections; indication of dimensions and tolerances; indication of surface or finish; symbols representing in a diagrammatical form certain elements of construction, as threaded parts, gears, etc.; the arrangement of drawings as to border line, title, notes; indication of changes and revisions, method of folding, etc.; the kind and size of lettering, figures, and symbols; scales of reduction or enlargement; sizes of filing cabinets; drafting equipment and tools (triangles, scales, etc.); specifications for materials to be used for drawings (paper, tracing cloth, inks, pencils, etc.).

The work will be carried out by a large sectional committee on which all interested groups will be represented, under the sponsorship of the American Society of Mechanical Engineers and the Society for the Promotion of Engineering Education.

* * *

The growth of the bus business during the last two years has been remarkable. The output of buses in 1925 was nearly 50 per cent greater than that in 1924, and it is likely that the output in 1926 will be still greater. Over 15,000 buses were built last year. The size and capacity of buses is also constantly increasing, and the riding comfort has been greatly improved during the past year.

DIES FOR DRAWING LIGHT-GAGE METAL*

By JOHN C. BIEMECK
Superintendent, Machine Department, Coonley Mfg. Co., Cicero, Ill.

Two-step dies of the type illustrated in Fig. 1, when used in a double-acting press, will accomplish results ordinarily obtained only on a triple-acting press. Thus the die here described permits two operations to be done at one stroke. It is well known that the lighter the gage of the metal used, the more difficult it is to draw smooth shells. If it were practical to draw some of the shells used in the class of work here considered from heavy metal, the drawing operations could be performed by ordinary dies, and two-step dies would not be required.

However, the material used for these shells is open-hearth pickled and annealed enameling stock of 29 gage, which is 0.014 inch thick. The blanks are cut, two at a time, on a blanking die, and drawn, three at a time, on a double-acting press. One of the drawing dies used for this work is shown in Fig. 1. The view at the extreme left shows the blank-holder *B* and the forming punch *A* in the position they occupy at the end of the up stroke. The next view to the right shows the blank-holder *B* in the position it occupies at the completion of its downward movement, while the view at the extreme right shows the forming punch at the end of the downward stroke, at which time the shell is completely formed.

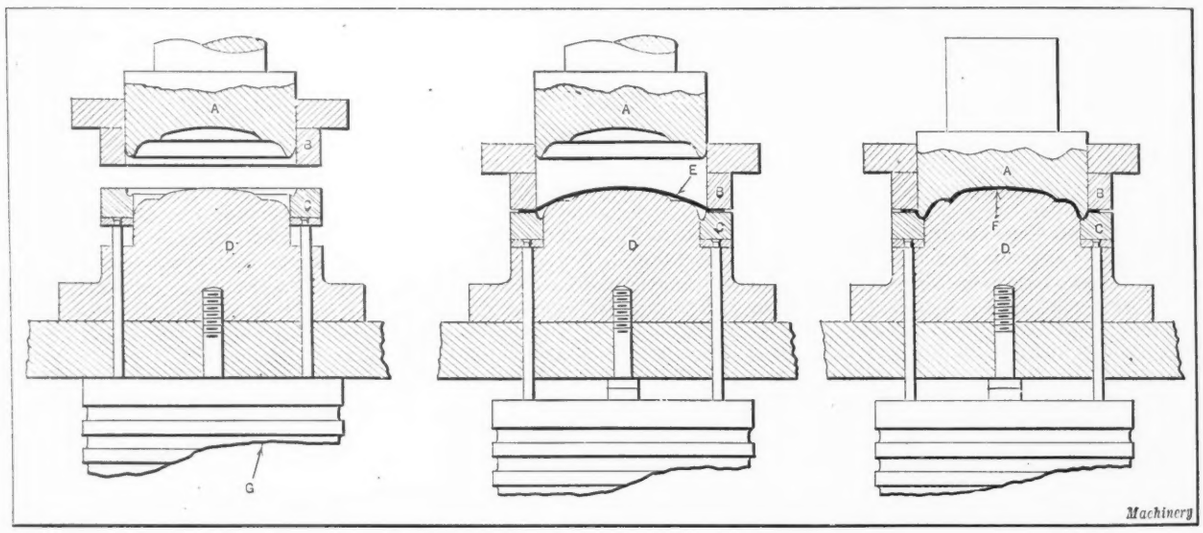


Fig. 1. Two-step Die used in drawing Thin Shells

When the die is in operation, the face of the pressure-ring *C* is on a level with the dome of the die forming member *D*. The blanks to be drawn are placed upon the pressure-ring *C*, which is held in position on a level with the dome of the die by the cushion *G* when the pressure-ring is in the upper position. The blanks are located on the ring *C* by stop-gages at the rear of this part. On the down stroke of the press, the blank is held between holder *B* and ring *C* while being drawn to the shape indicated at *E*. As the pressure-ring continues to descend, the punch *A* descends and forms the shell over the member *D*, as indicated at *F* in the right-hand view.

It would be practical to cut and draw the material in one operation if the die-holders of the double-action press were guided by gibs, but as the presses available were not so equipped, this could not be done. However, the handling of the scrap stock slows down such operations, and it is often a question whether or not anything is gained by blanking and drawing at the same time.

The presses now used for blanking run at a speed of 120 strokes per minute, and those for drawing, at 25 strokes per minute. However, only about 400 strokes per hour are actually employed for drawing, but as three blanks are drawn at a time, about 1100 shells are produced per hour. Two blanks

*Abstract of a paper read before a recent meeting of the National Pressed Metal Society.

are cut at each stroke, and the production for this operation is about 1000 pieces per hour. Before the two-step type of die was used, two drawing operations were necessary, whereas now only one is required. The production has, therefore, been increased about 100 per cent by adopting the new method.

The object in using double draw-ring dies is to perform in one operation what usually requires two or three operations. Dies of this type, one of which is shown in various operative positions in Figs. 2, 3, and 4, cut the blank and form two steps in the cover, while the outer and inner draw-rings act as one member. As the punch continues downward, the inner draw-ring is stopped by a shoulder in the die, and the outer draw-ring travels down against the pressure supplied by the air cushion. The latter movement forms another step in the cover. Finally, the floating center of the punch, which is at first supported by the springs, comes in contact with the holding member and gives the cover its finished form.

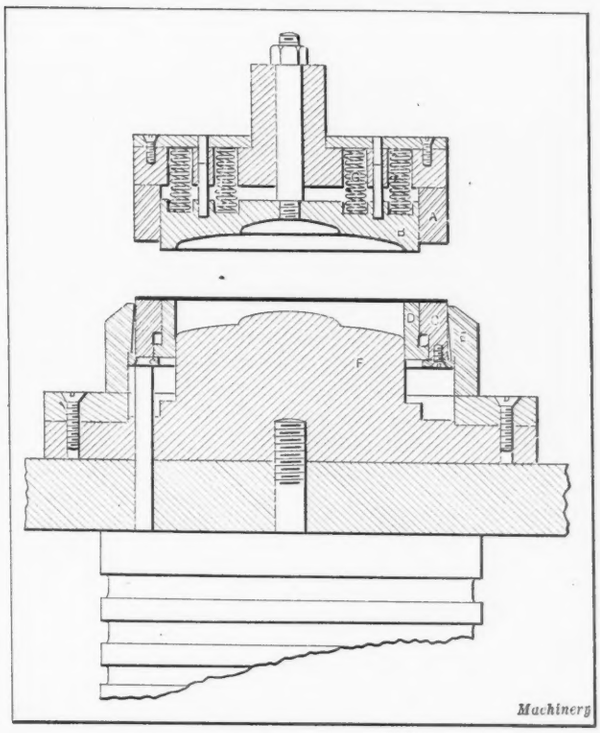


Fig. 2. Double Draw-ring Die

As the pressure-ring descends, the part *B*, Fig. 2, comes in contact with part *D* and compresses the springs *G* until part *A* strikes member *C*. As the punch continues downward, the cutting edges of parts *A* and *E* cut the blank from the stock. The blank is forced downward until it reaches the position shown at *G*, Fig. 3, at which time the member *D* is in contact with a shoulder on the die member *F*. The part *C*, or outer draw-ring, is supported by an air cushion which allows it to descend in such a manner that the final step in the cover is formed between the parts *A* and *C*. On the further downward travel of the punch, as shown in Fig. 4, all the springs or cushion-backed members are seated against solid shoulders and sufficient pressure is applied to give the work its final form.

COMMERCIAL ARBITRATION

Commercial arbitration has long been found by business men to be, under favorable circumstances, a workable substitute for litigation. The United States Arbitration Act applies to all business disputes where the contracting parties are citizens of different states and when an amount as great as $3000 is involved; in a number of states there are separate arbitration acts relating to business conducted within the state. The chief advantage to be gained from arbitration agreements is the avoidance of the shortcomings of our antiquated legal system which is not adapted for modern conditions. These shortcomings are summarized in *Commerce Monthly*, published by the National Bank of Commerce, New York, as follows: (1) The long delay incident to proceeding at law; (2) expense of litigation; and (3) failure through litigation to reach a decision regarded as just when measured by the standards of the business community.

* * *

ANNUAL MEETING OF AUTOMOTIVE ENGINEERS

The annual meeting of the Society of Automotive Engineers was held in the General Motors Building, Detroit, Mich., January 26 to 29. Special sessions were held relating to automobile superchargers, research, standards, aeronautics, brakes, body production, engines, headlightings, motor coaches, vapor cooling, fuels, lubrication, and production. At the production session papers were read by Joseph Lannen, Paige-Detroit Motor Car Co., on "The Application of Group Bonus to Non-productive Labor"; and by J. Ledwinka, E. G. Budd Mfg. Co., on "The Production of All-steel Bodies Shown by Motion Pictures."

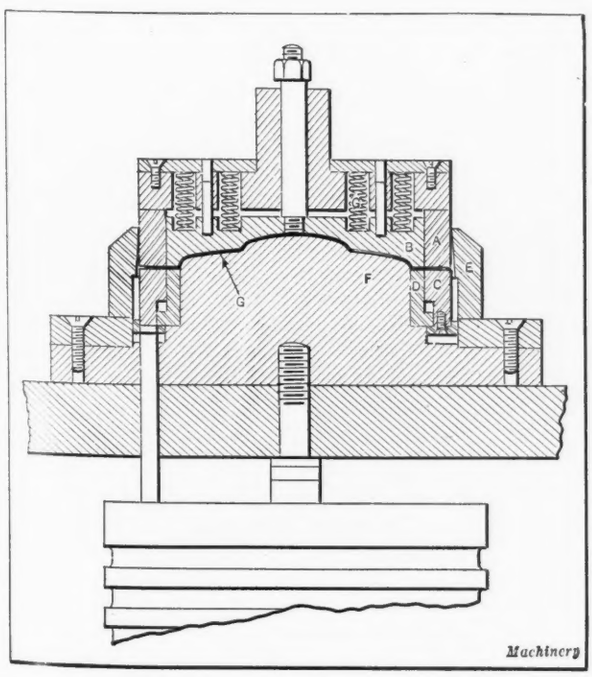


Fig. 3. Die shown in Fig. 2 with Work partly formed

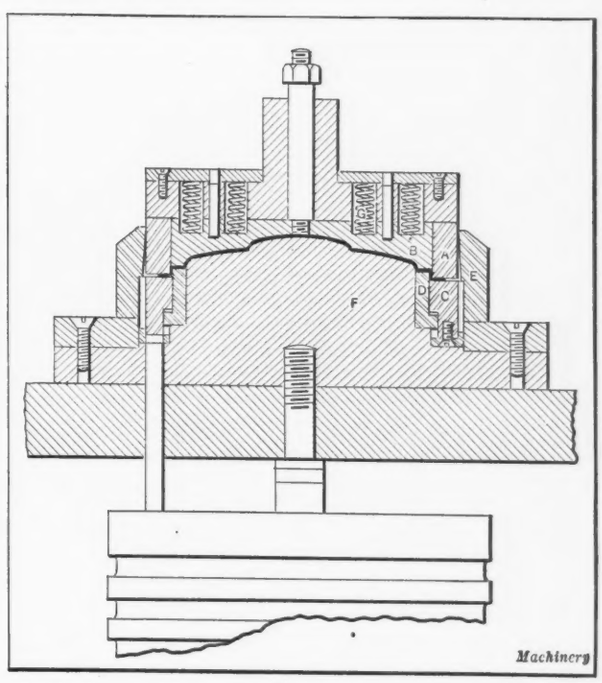


Fig. 4. View showing Position of Die Members at End of Stroke

The British Metal-working Industries

From MACHINERY'S Special Correspondent

London, January 15

IN the metal-working industries, the year opens with great possibilities, as compared with the slender hopes of improvement that were expressed in January, 1925. The past year began and ended well, but the summer and autumn witnessed disconcerting set-backs that were felt by practically every branch of engineering industry. Fortunately serious labor troubles —with one important exception—were avoided during 1925. The exception was the strike threat by the coal miners, a trouble hung up by a subsidy until next May at a very heavy expense to the community.

The Machine Tool Industry

In the machine tool field in 1925, many signs of revival prove that the prospects are satisfactory for the first time since 1920. The vitality of the industry is seen in the large number of new designs that have been placed on the market. The automobile industry has exerted a considerable influence on machine tool design during the past year, and the requirements of the railway and the airplane engine fields have also been closely studied. Coupled with this, is the extensive development of simple single-purpose semi-automatic, and special machine tools.

In standard types of machine tools, no startling innovations have been marketed during the past year by British makers, who have concentrated upon incorporating in their designs those details that have been proved to make for ease of handling, efficient tooling, and more rapid production. In the aggregate, these detail improvements are capable of increasing output to a marked extent. A stage has now been reached by the British machine tool maker where further progress is limited by tool steel, despite the remarkable capabilities of some of the modern high-speed steels.

The Birmingham area remains the high spot of activity in the machine tool industry. Without exception, machine tool shops are well off for orders, and for some time, the rate of production has compared favorably with full pre-war capacity. Orders are accumulating, and for some types of machines, deliveries are months ahead of order dates. Plant additions and extensions are fairly general. Some of the largest orders for turret lathes and screw machines ever received are now going through. Automatic chucking machines, grinding machines, lathes, milling machines, shapers, and drilling machines are all in good demand.

The last quarter of 1925 saw a considerable increase in activity in the Yorkshire machine tool centers. Standard products generally are in good demand. Radial drilling machines, shapers, planers, especially those up to 5 or 6 feet, and lathes of all sizes, are well represented in current orders, and business generally shows a steady upward trend.

In Manchester and district, the steadily improving tone of general engineering is having a good effect on machine tool business, although orders for overseas predominate. Textile machinery makers are again in the market for machine tools, and special machines figure among orders in hand for this market. Grinding machine makers are fairly busy, and inquiries are numerous for horizontal boring machines. Grinding wheel makers in this district are extremely busy on both overseas and home orders.

Scottish machine tool firms are not so well placed as those in other centers, and orders are spasmodic. It is hoped, however, that a good proportion of the New Zealand Government Railway requirements will be met from this locality.

Overseas Trade in Machine Tools

The returns for the export of machine tools during November show a falling off in tonnage and value over the figures for October. For the latter month, the tonnage exported was 1098, with a value of £113,941, while for November, the corresponding figures were 961 and £104,895. The ton-value of exports during October and November was, therefore, £104 and £109, respectively. In imports, however, the November figures showed a surprising jump, which so far as values were concerned, almost reached the export level—a very exceptional condition. The figures for November's imports were 764 tons, with a value of £97,970, which represent considerable advances over October's figures of 452 and £74,097, respectively. This sudden leveling up of imports and exports in November was accompanied by a fall in import ton-value to £128 from £164 in October.

Lathes constituted the most valuable group of exported machine tools, amounting to over £40,000, or about 40 per cent of the total. Drilling machines, which amounted to £22,000, were also a valuable item in the export returns.

General Engineering Field

The new year has opened with excellent prospects for the immediate future, and engineering in all its branches shows substantial improvement. Rolling stock builders had a busy year in 1925, and start 1926 with a good number of orders on their books. The London, Midland & Scottish Railway program for 1926 includes 15,000 freight cars, which, with 400 new locomotives, will cost £5,000,000 of a total proposed expenditure on renewals and extensions of £8,000,000. Many other important locomotive and rolling stock orders have been placed or are expected.

Extensive power station developments by local authorities at home and overseas continue to provide abundant work for heavy electrical equipment manufacturers. The big electric development schemes foreshadowed by the government for improving and cheapening current supply and application in rural and agricultural districts are also very encouraging to the electrical industry generally. The general improvement in engineering is reflected in the applications for exhibiting space at the forthcoming British Industries Fair in Birmingham, where the engineering exhibits will be three times as extensive as last year.

The Automobile Industry

The automobile and motorcycle trades present remarkable prospects. The last twelve months constituted a record which, however, is expected to be easily surpassed by 1926. Most automobile factories in the Midlands are busy with factory extensions, and not only are cheap light cars still selling in unprecedented numbers, but makers of the more expensive types could sell easily more than they can produce with their existing equipment.

The export trade in automobiles, motorcycles, and bicycles is keeping well abreast of the home trade, and certain firms have had to build separate factories for packing for shipment. The demand for commercial motor vehicles is now very large, and 1-, 2-, and 3-ton trucks form a large proportion of the output.

Shipbuilding

The Clyde has come through another year of depression in shipbuilding, and general employment has been approximately only equal to that of 1924. The tonnage launched during 1925 was 251 vessels of a total of 538,020 tons, as compared with 280 of 523,320 tons in 1924. On the North East coast there was a heavy fall in the tonnage launched, and this area did not hold its own so well as the Clyde. Recent severe weather has brought in much repair work to the shipbuilding centers.

NEW PROCESSES FOR MAKING WROUGHT IRON

The notable progress made in recent years in the development of mechanical methods of puddling for the production of wrought iron was outlined in an article in *Mechanical Engineering*, of which the following is an abstract. When the Bessemer process was invented, it was generally believed that the days of wrought iron were numbered. Bessemer steel, after the first manufacturing difficulties were overcome, seemed to present so many advantages over the older metal that it did not appear possible for the latter to survive. Actually, however, wrought iron not only continues to exist but shows possibilities of expansion. It has certain advantages, such as higher resistance to atmospheric corrosion, and while generally the tensile strength of wrought iron is lower than that of steel, a notched piece of wrought iron actually shows higher resistance to alternating stresses than steel.

The greatest obstacle to the increased use of wrought iron was the process of its manufacture. Wrought iron was essentially a hand-made product. Not only that, but its manufacture required in the man producing it a rare combination of great endurance, great physical strength, and skill, a combination which is obviously difficult to satisfy on a large scale with the labor of today. Before wrought iron could become a heavy-tonnage product capable of satisfying a large market, it was necessary to mechanize its production.

The Puddling Process

The ordinary double puddling furnace is of simple construction, consisting of a fire chamber, a working hearth, and a flue. The bottom of the hearth is composed of pure oxide of iron resting upon a cast-iron air-cooled bottom. The sides of the hearth are formed of iron ore, technically known as "fix" or "fettling."

The process itself is quite simple. After the pig iron is charged, the puddler endeavors to fuse the whole charge at as nearly one time and at as low a temperature as possible. This is accomplished by moving the pigs about with a paddle or "rabble," thereby exposing fresh surfaces to the flame and to the dissolving influence of the cinder bath. The cinder produced during the welding oxidizes and absorbs a large portion of the silicon and manganese. As the temperature increases, rapid decarbonization takes place, giving off a large volume of carbon monoxide which causes the bath to swell or "high boil." Vigorous agitation of the bath is vitally important throughout the process, to produce uniform conditions in all parts, and to prevent any portion continuing to rest upon the relatively cool bottom.

Mechanical Systems of Puddling

To puddle iron successfully by mechanical means, it is necessary to approach as nearly as possible the conditions in the hand furnace—in other words, it means being able to mix iron and cinder intimately, to expose every part of the sponge to the heat, and to have full control of cinder and flame conditions. Within the last few years, several designs have been tried out in which it is claimed that this problem has been more or less successfully solved.

At the Reading Iron Works, Reading, Pa., the Roe furnace is in operation. This furnace is rectangular in shape, being 12 feet wide and 24 inches deep. It is so arranged that it can oscillate through an angle up to 120 degrees. The furnace is operated in the following manner: The working bottom, which is formed of pure oxide of iron, is obtained from a small tilting open-hearth furnace in which the oxide is melted. It is then poured into a cast-iron ladle and charged into the puddling machine through a hole in the side near the rail. It flows uniformly over the bottom where it rapidly congeals, as its temperature of fusion is high. Following this, the puddling cinder melted in the same type of furnace is charged in the same manner and flowed over the bottom and over the door joint, where it congeals and forms a liquid-tight joint. Immediately after this, molten iron from a mixer is charged. Next, the oxidizing agent—roll scale— is charged by means of a long spoon, which distributes the scale uniformly through the whole width of the furnace.

Between spoonfuls the machine oscillates rapidly about 45 degrees each side of the horizontal. During this period air and gas are shut off, producing an oxidizing atmosphere in the furnace, and all the silicon and manganese is oxidized. Gas and air are then admitted, and as the temperature increases, the reactions become apparent and increase in intensity until the high boil is attained, which is the period of the most rapid decarburization; during the whole of this period the machine is moved rapidly, producing violent agitation of the whole bath, with intermissions between each successive five or seven oscillations.

As evidence of the "drop" appears, that is, when most of the carbon has been eliminated, the motion is changed to an extremely slow one, and at a somewhat smaller angle, the object now being to prevent the plastic and partially refined mass from going together, as, should it do so, the center of the mass would not be completely refined. Keeping the iron sponge open at this period is a vital feature, and one that the particular form of bottom used is intended to attain.

The whole period of making a heat averages 60 minutes. It is said that the Reading Works has averaged 1000 tons per furnace per month, equivalent to the product of ten ordinary double puddling furnaces, that is, the productive effort of a skilled puddler is increased twenty-fold.

The complicated and inefficient handling of the product of the puddling furnace is also eliminated in the new process, where the ball is romoved as a whole and squeezed in a hydraulic squeezer of a special kind. The so-called muck-bar stage is entirely eliminated, and the bloom is squeezed to sizes suitable for rolling, in a blooming mill, and cut to weight in the finishing mill, the blooms taking the place of piles made up of muck bars. From a metallurgical standpoint, this is considered to be a better procedure, as it largely eliminates laminations such as occur in wrought iron piled from small units.

Rotating Furnace Method

Another process for making wrought iron has been patented by W. C. Ely, of Terre Haute, Ind., the patents now being owned by the American Chain Co. In this process, a furnace is employed which is so arranged that it can be both rotated and oscillated. Fuel oil is used as a fuel, although pulverized coal has been successfully tried out and ordinary coal can be used in certain ways. In the course of the operation, the furnace lining is first heated to a temperature of 2400 degrees F., after which a quantity of iron turnings and ferric oxide is introduced in small pieces into the furnace chamber. The furnace is then rotated until the "fix" softens and finally flows freely, ultimately adhering in a solid coating to the magnesite lining of the furnace. A mixture of brown and red hematite ore is used to seal the edges of the lining around the ports where they are exposed. This is claimed to produce a good wear-resisting bottom.

After the lining of the furnace is prepared, a quantity of rolled scale and cinder is shoveled in, and after these are partially melted or fused, the furnace is rotated into the proper position and a charge of molten pig iron poured in. As soon as this is done, the door is closed and the furnace rotated enough to cause the slag, which now is fluid, to flow to the door sill and jambs and seal the furnace door tightly. The temperature of the furnace is maintained with a reduction in the air supply in order to bring on a boil. During this period, the furnace is oscillated through an arc of about 60 degrees, and rolled scale is added. As the boiling period recedes, the metal commences to "come to nature," with a lowering of the temperature of the charge, the furnace during this period being oscillated constantly in order to break up the slag film and expose the granules of the metal to the decarbonizing action of the slag and flame. When the metal has fully "come to nature," the furnace is rotated to form the mass into a ball, and at the same time the furnace temperature is maintained at a melting heat so that the particles of iron are homogeneously welded together and the slag maintained fluid. It is very important that the slag be of

such a character that, while viscous enough to stick to the iron, it will not be so basic as to require extremely high heating for producing welding in subsequent operations.

Another process, developed at the plant of the Titan Steel Co., Jersey City, N. J., is the invention of Henry D. Hibbard. The principle of this process is based on the production of an intimate mixture of molten iron and oxide of iron by making the charge pour repeatedly over a dam in a thin stream in an oscillating furnace.

The melting stage is carried on in a cupola, from which the molten iron goes into the puddling furnace where the operations of purifying, boiling, and balling follow mechanically the hand method. Essentially, the furnace consists of a cylinder of steel plate about 6 feet in diameter and 5 feet 6 inches long, with projecting trunnions 18 inches in diameter. The cylinder is lined with magnesite brick to an inside diameter of about 4 feet. The dam, which consists also of magnesite brick, extends up nearly to the center line. The operation is carried on at a temperature of about 2650 degrees F., the flame temperature, using oil fuel, being 2850 degrees.

As soon as the iron begins to form into a ball, the oscillating motion of the furnace is stopped and the furnace is rotated clear over. The ball is carried to a squeezer, where it goes down through a passage of continuously decreasing dimensions and thence it is expelled in rough cylindrical form at the far side, free from surface slag and prepared for the breaking-down rolls. The iron is used largely for pipe and sockets, engine bolts, staybolts, and high-grade merchant bars. Its physical properties are reported to vary in tensile strength from 45,000 to 52,000 pounds, and in elongation from 15 to 30 per cent.

Disintegration Process

A method developed by James Aston, metallurgist, A. M. Byers Co., Pittsburg, Pa., is essentially different from those previously described. In this case, disintegration of the metal is referred to as the keystone of the process. This is brought about in the following manner. Molten iron has a solidification point of about 2730 degrees F., while the slag fuses at about 2100 degrees F. Therefore fused slag is a chilling agent for fused iron, and when molten iron is poured into a bath of slag there is almost instant solidification of the metal and a gas-liberation of such force that the metal is blasted into particles. These particles settle and collect at the bottom of the slag bath in a spongy, porous mass entirely similar to a well-worked puddled ball. Because of heat interchange, the slag not only remains liquid but becomes hotter and permeates all the interstices of the metallic mass.

With proper proportions of metal and slag, final temperature equilibrium may be reached at 2500 to 2600 degrees F., which is a welding heat for iron. The excess slag may be drained off and the mass compacted into a solid bloom in a squeezer or press. It is important that the final temperature equilibrium should be safely below the fusion point of the metal, as otherwise the last portion poured may remain liquid and coalesce as a steely, slagless area in the bloom.

Experiments have been in progress for several years at the works of the A. M. Byers Co. in Pittsburg, and the existing experimental plant has been operated since February, 1920. About 850 heats have been made, producing blooms ranging in weight from 300 to 1000 pounds. The material produced is said to have satisfied the most exacting specification for high-grade wrought iron. Considerable amounts have been rolled direct from the bloom to skelp or plate without repiling, and then made into pipe of entirely normal characteristics.

Hitherto wrought iron has cost more than steel per ton to produce. With the new methods, however, there are possibilities of operating costs in its manufacture closely approaching those of steel manufacture.

It has been pointed out by H. E. Smith, Engineer of Tests, New York Central Lines, that to make the largest sizes of present-day finished product, it is necessary to have a larger mass of iron than the old-time hand puddler can manipulate. This is doubtless one of the incentives in the present study of methods and apparatus for operating a puddling furnace mechanically or else by some method other than puddling, to produce a metal having the same composition, structure, and properties as hand-puddled iron. These new methods and apparatus are aimed at the production of a unit mass of iron many times the size of the old hand-puddled ball. The consumer is very much interested in these developments, and hopes to find in them a source of large sections of solid, tough wrought iron free from open seams, and at the same time at a price enough lower than the present standard to enable him to extend the use of iron.

* * *

LEATHER BELT TRAVELS MORE THAN NINE MILLION MILES

A leather belt installed at the Bernon Mills, Georgiaville, R. I., in 1876 has, during its lifetime, traveled 9,387,200 miles. This belt is 130 feet long, 42 inches wide, and is said to be the first three-ply belt ever made. In 1911, after being in use for thirty-five years, the ply next to the pulley was replaced, but aside from this no other repairs have been made. Owing to a broken main shaft on the engine, the old belt was replaced, although it probably could have been used for several years more if necessary. The engine driving pulley over which this belt has been running is 30 feet in diameter, and the driven pulley, 7 feet in diameter. The center distance is relatively short for a belt of this size, as the pulley rims are only 13 feet apart. The belt was installed originally to transmit 500 horsepower with the engine operating at 45 revolutions per minute, but after several years there was a demand for more power, and the engine speed was increased to 61 revolutions per minute. Hence, the belt speed during the larger part of its life was 5740 feet per minute, and the driving tension under normal load, 110 pounds per inch of width. This belt cost $1317 in 1876. By adding the cost for repairs and deducting the salvage value of $300 it has been found that the total cost of transmission is 4.2 cents per horsepower per year.

* * *

FAVORABLE AND OBJECTIONABLE FACTORS IN THE BUSINESS PROSPECT

Secretary Hoover states that this country produced and consumed more goods in 1925 than ever before in its history. Among the favorable indications for continued prosperity, Mr. Hoover points out improvements in education; advancement in scientific research; elimination of waste; moderate stocks of commodities; employment possible for practically everyone; high level of wages, as compared with cost of living; largest savings in the country's history, and, therefore, abundant capital; greater operating efficiency of the whole machinery of production and distribution than ever before. There are, however, some phases of the situation that call for caution. Among the danger signs may be mentioned the continuation of real estate and stock speculation and its possible extension into commodities, which would be followed by inevitable inflation; the over-extension of installment buying; the foreign government-fostered monopolies that dominate some of our raw material imports; the continued economical instability of some foreign countries; the slow recovery of some of the agricultural sections; the unsatisfactory state of the coal industry; and the uncertainties in some important labor relationships.

* * *

The committee of judges of the American Foundrymen's Association awarding the S. Obermayer prize have awarded the 1925 prize to H. W. Dietert and W. M. Myler, Jr., of the U. S. Radiator Corporation, Detroit, Mich., for a continuous iron temperature recorder to be used in connection with continuously operated cupolas. The committee awarding the prize was composed of Benjamin D. Fuller, past president of the American Foundrymen's Association, who acted as chairman; A. E. Wells of Cornell University; and W. Dosey of the Carnegie Institute of Technology.

SELECTION OF FUEL FOR THE HEAT-TREATMENT OF METAL

By J. A. DOYLE, Vice-president, W. S. Rockwell Co., New York City

Selection of a suitable fuel, or electricity, for heat-treatment processes should be made with an appreciation of the fact that the value of the result sought is to be measured by the quality and over-all cost of the finished product—not merely by the price or consumption of fuel or electricity, temperature record, heat balance, or some such incidental phase of the heat-treatment process as a whole. The real problem, from the manufacturer's point of view, is that of producing a high quality product at low cost, and the use of such form of fuel, or electricity, and such character of equipment for heating, cooling, and handling as will produce this result under his specific manufacturing conditions.

No One Fuel is Best For all Conditions

Any method of selection, based on abstract comparison of different forms of fuel, or electricity, and the claimed advantages of one over the other, is inaccurate and misleading. Each fuel has its field of usefulness, as well as its limitations, all of which vary with the nature of the heating process, the type of furnace or other heating appliance, the method of operation, the manufacturing requirements, the plant conditions, and many other factors, any one of which may influence the choice under specific conditions.

Much of the prevailing conflict of ideas on the subject is due to a misunderstanding of the relation of the so-called "fuel problem" to the real problem that confronts the heat-treatment department—the quality and over-all cost of the finished product—or to commercial propaganda calculated to further the use of some particular form of fuel, or electricity, or some special form of apparatus or material to which that specific form of heat energy may be adapted.

The situation is very confusing to one concerned with the selection of industrial heating equipment properly adapted to his specific requirements. He is confronted with the conflicting claims of enthusiastic advocates of many different forms of fuel, electricity, furnace material, or heating apparatus; and with evidence or opinion as to the success or failure of other installations. He longs for recourse to a recognized Court of Appeals for an unbiased opinion of the relative merits of the many different forms of solid, powdered, liquid, or gaseous fuels; of the arc, resistance, or induction methods of heating electrically; and of the unending variety of different types of furnaces or other heating appliances adapted to these various heating media.

General Factors to be Taken into Account in Selecting a Fuel

In considering solid fuels, he learns something of the claimed relation of hand-firing to stoker-firing of different forms of bituminous or anthracite coal, and of powdered coal. Consideration of fuel oil raises a question as to the suitability of heavy oil or light oil. A choice is made difficult by conflicting claims for dozens of different types of so-called "oil burners" designed for steam, high- or low-pressure air (or both), and of an equally great variety designed to atomize mechanically. He is informed that gas is the best fuel, and wonders if it should be city gas, natural gas, water gas, oil gas, mixed gas, hot or cold producer gas, or some other form of gas.

A desire to avoid the difficulties with fuel leads to thought of electricity, and of the possibilities of either the arc, induction, or resistance methods; of resistors in different forms of refractory or metallic material; of round wires, or flat wires, that may be exposed or muffled; of cast or rolled metallic units; of high and low frequency; of the possibilities of automatic temperature control with fuel or electricity, and so on.

When proper study of the problem as a whole discloses the fact that the economic relation of the many different forms of fuel or electricity continually varies with an unending and ever-changing variety of furnace designs, he may conclude that when no one knows, every one has a right to guess. So he makes his guess.

A Better Understanding of the Real Problem is Desirable

This statement of an undesirable condition is not overdrawn, as it illustrates part of a time-wasting process of more or less useless discussion that is of daily occurrence. It is imperative that a more commen-sense perspective of the problem should be cultivated to encourage proper development of the many industrial arts in which heat plays a prominent part; to effectively contribute to the conservation of energy resources; to provide better working conditions for operatives in the shops; and to encourage more constructive thought on the real question at issue, that is, the quality and over-all cost of the ultimate product or service.

A good move, in the direction of improvement, would be to cultivate the thought that many of the prevailing ideas, and much of the discussion, is really beside the point at issue; that no one form of fuel, food, or medicine, is suitable for the general run of requirements; that an attempt to urge the use of any one form of furnace or heating appliance is the equivalent of an attempt to devise one form of dwelling to meet the country-wide requirements of housing, or to provide one form of fuel or equipment for all the domestic heating operations in that dwelling; that we are more concerned with the practical problem of heat-treatment than with the theoretical condition established by the usual discussions of the so-called "fuel problem," most of which are as constructive as a debate on the relative merits of wine or water as a beverage, without sufficient thought of the purpose, or occasion, for which the respective fluids may be properly considered.

It is More Important to Consider the Results to be Obtained than the Fuel

We can well do with less useless discussion about fuels and more constructive thought of the underlying principles affecting the heating, cooling, and handling of products to be heat-treated, and the comfort of the operatives. A perspective of the problem from this angle will pave the way for constructive thought in the matter of selection of fuel, or electricity, and equipment.

It is in order to encourage such view in the interests of the art and all those concerned with the practice of it. The journals devoted to fuel oil, city gas, natural gas, coal, electricity, and other forms of heat energy, or equipment or material adapted to them, continually carry matter calculated to convey the impression that the particular form of heat energy to which the publication is devoted is better than any other; and evidence in the form of tests or replacements of one by the other is offered to support such contention. This, on the very face of things, is an illogical condition.

Improvement is not likely to be effected until it is appreciated that whatever is best for the art as a whole should be good enough for everyone connected with it. Those concerned with the development of different forms of heat energy or equipment should realize that each has its field of usefulness, as well as limitations; that the proper economic relation between any two (at a given time and place) can be most effectively determined by comparison of the nature of the equipment considered with each, and the suitability of the combination as a whole to the requirements of the case in hand.

* * *

A CENTURY OF SCIENTIFIC JOURNALISM

The *Journal* of the Franklin Institute has just completed one hundred years of uninterrupted publication. The first issue was published early in 1826. Since its earliest days this journal has been devoted specifically to scientific developments of noteworthy character. During these hundred years science has changed in both character and method of attack. It has ceased to be largely, if not wholly, experimental and descriptive, and has become, especially in its physical and chemical branches, extremely analytical. Some of its most brilliant successes have been won by methods of mathematical analysis. There is a marked tendency in industrial management at the present time to appreciate the need for and value of pure scientific research.

The Machine-building Industries

THE production of basic commodities continues to be about the same as during the last three months. In November, the last month for which complete statistics are available, the output of manufactured products, according to the Department of Commerce, was 32 per cent greater than the monthly average for 1919, which is taken as a basis for comparison. The survey of the Department of Commerce covers sixty-four different commodities, and hence is representative in character. Production in November was also 16 per cent higher than a year previously; all the industry groups showed a gain in production, except the leather industry, which remained at the same level. In the iron and steel industry a gain of 24 per cent has been made, since November, 1924, and in other metals, 5 per cent. The automobile production in November, 1925, was 60 per cent higher than a year previously. Increases were also noted in the number of building contracts awarded; in thirty-six states, the awards in building contracts during 1925 averaged 40 per cent higher than in 1924.

The Machine Tool Industry

The demand for machine tools continues to be active, and the volume of orders is approximately twice as great as the average for 1922, 1923, and 1924. Ernest F. DuBrul, general manager of the National Machine Tool Builders' Association, points out that so much of the present demand is coming from the automotive industry that this field deserves careful watching for the next few months. He considers it unlikely that the automotive industry will continue to purchase throughout the year as heavily as it has done recently.

On the subject of general demand, Mr. DuBrul makes the following statement: "Our statistical reports and charts furnish a very good index of the situation as to industrial equipment generally. We judge from these figures that, with the accumulation of capital and the increased production of goods, there is a confident feeling in the country. This leads to some expansion of facilities and to considerable replacement of older equipment. But this feeling is only about half as strong as it was in the boom of 1919 and 1920, since our index is only about half as high as it was in those months. But we believe that the present demand is much sounder than the hectic demand of those boom years was, and should last longer."

Most machine tool builders have business in hand for several months to come, and in a number of instances present orders will not be filled until May or June. Over-time and night work is again the rule in many machine tool shops, and several plants are working nearly to capacity for the first time in five years. Many manufacturers state that the export business is very satisfactory.

In the small tool industry, a similar activity is in evidence. It is of interest to note that in these plants the order and shipping departments have generally had to be increased to take care of the great number of small orders that have to be filled at the present time, as compared with the smaller number of orders required in the past to furnish an equal volume of total business. The ordering in small quantities on the part of the customers of the small tool industry has materially increased the costs of this industry.

The Iron and Steel Industry

The iron and steel industry is the basic industry in the entire metal-working field. The steel output in 1925 was greater than in any previous year. Nevertheless, stocks are reported small and demand continues strong. The pig iron output was over 15 per cent greater in 1925 than in 1924; yet, in this field also, small stocks and good demand are the rule. The United States Steel Corporation operates at 87 per cent of capacity, and it is believed that the present level of production will be maintained for some months. There are approximately 230 blast furnaces in operation, which is slightly under the 60 per cent considered "normal" under what is being termed the "Ayres theory." This would indicate that there is no danger of over-production or of an accumulation of stocks that might demoralize the market.

As an indication of the activity in the iron and steel industry during 1925, it may be mentioned that the production was approximately 27 per cent greater than the average for the six years preceding the war. In other words, if 1925 is considered a "normal" year, the consumption of iron and steel in this country has increased approximately 25 per cent in the last fifteen years.

Steel casting production in November was higher than in any month since January, 1925. Malleable casting production decreased slightly from October, but otherwise was greater than for any month since January, 1925.

The Automobile Industry

The general characteristics of the automobile situation at present, as compared with a year ago, are: Somewhat higher production, a larger number of cars in the dealers' hands, and some congestion of used cars reported from some centers. Manufacturers state, however, that the dealers' stocks are not larger than is consistent with sound business methods and that they were too small at this time last year.

The truck industry had a record year in 1925, the production being over 20 per cent greater than in any previous year. A continually increasing demand for trucks is expected, as well as a steady business in buses.

One of the events in the automotive industry last month was the International Motor Transport Congress held in New York, at which delegates from fifty different countries were present. The significance of this gathering may be appreciated when the great increase that has taken place in the foreign trade in automobiles during the past year is remembered.

The Railroad Situation

Railroad traffic remains at a high level, with no obstacles in the way of efficient service. The number of surplus cars on hand to care for any increase in traffic is quite large. In 1925 the railroads established a number of records for efficient handling of freight. The greatest freight traffic in history, measured by the number of cars loaded with revenue freight, was carried. This traffic was handled with practically no car shortage or transportation difficulties, and at no time were there less than 103,000 surplus cars and 4200 surplus locomotives in serviceable condition. The average daily movement of all freight cars reached a high record in October at 32.2 miles, which exceeded the previous high record for any one month by 1.5 miles. Another increase in the operating efficiency was recorded in August, when the average load per freight train was 796 tons, an increase of 26 tons over the previous record made in October, 1924. Less fuel was consumed during the year in proportion to the amount of freight traffic handled. The average consumption of fuel for the first ten months of 1925 was 138 pounds for the movement of 1000 gross tons of freight and equipment one mile. In 1924, 148 pounds, and in 1923, 160 pounds were used. During the past year the railroads authorized in capital expenditures over $1,200,000,000, of which approximately $775,000,000 was spent during the year, the remainder being carried over for work to be completed in 1926.

Nearly 1800 steam locomotives were placed in service in 1925, as well as more than 130,000 freight cars. It is expected that during the coming year there will be a greater number of both locomotives and cars ordered and placed in operation than during 1925.

New Machinery and Tools

The Complete Monthly Record of New Metal-working Machinery

AMERICAN HYDRAULIC BROACHING MACHINES

Three broaching presses which are operated hydraulically constitute the latest developments of the American Broach & Machine Co., Ann Arbor, Mich. The machine illustrated in Fig. 1 is of the vertical type and has a capacity of 8 tons. It is operated by means of a hydraulic cylinder, a constant-flow pump, and a throttle valve. The downward travel of the ram may be varied from 0 to 16 feet per minute. This machine can be operated at a very light pressure on delicate work, or, by a slight movement of the operating lever, the entire force of the ram can be applied to the work. On classes of work where it is desired to operate under a certain pressure, the relief valve can be set so that the pressure cannot exceed the desired amount. This is a decided advantage in assembling bushings and other parts.

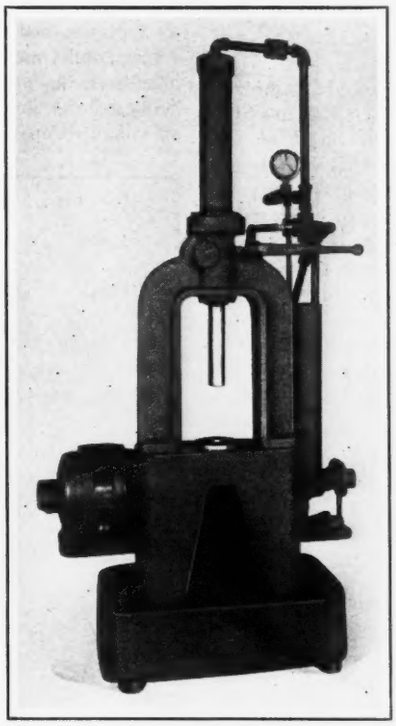


Fig. 1. American Vertical Broaching Press

The ram is 2 1/2 inches in diameter; the cylinder, 4 inches in diameter; and the ram stroke, 18 inches. A full-flow pump of the twin-screw type having only two rotating members which are submerged in oil, is provided. The lower end of the ram is tapped to receive connections such as are used on horizontal broaching machines. Stops control the length of stroke. At the end of each stroke, the ram is automatically returned to the upper or starting position by means of springs, this feature saving the operator considerable time.

The table is bored central with the ram, and is equipped with a reducing bushing. A gage calibrated in pounds and tons permits a direct reading of the pressure under which the machine is operating at any time. A pump supplies lubricant to the work. If desired, a foot-treadle control can be furnished. The machine occupies an operating floor space five feet square.

The No. 3 horizontal machine illustrated in Fig. 2 is operated by two cylinders which are arranged parallel to the bed. The two operating rams and the pulling ram are tied together by a steel cross-head in such a way that they all move as one unit. The oil pressure is applied directly against the ends of the pistons, and there is no heavy pressure on the end of the cylinders through which the ram moves. Among the advantages claimed for this construction are a balanced pull and the elimination of leaky packing glands. The cylinders do not need to be very large, since the high pressures are applied on that side of the piston where the ram does not cut down the working area.

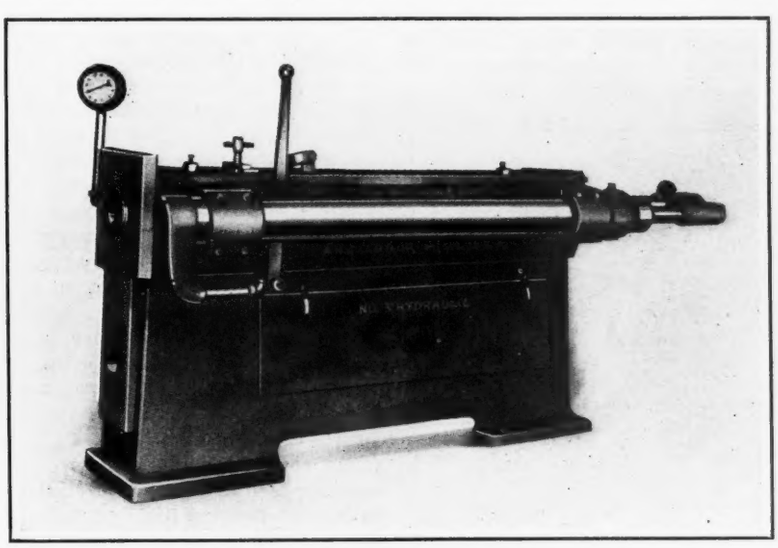


Fig. 2. Flexible Hydraulic Broaching Machine of the Horizontal Type

The pump provided on this machine is of the variable-flow type and of a constant pressure, so that it is possible to operate the machine at any desired speed to suit the particular tool being used or the work being broached. The operating lever is connected to a shaft on which stop-dogs can be set to give any predetermined length of stroke. An adjusting collar on the same shaft at the back end of the bed can be set to regulate the speed from 0 up to 20 feet per minute to suit the operation. The return speed is 40 feet per minute. A gage is provided that is calibrated to indicate the number of pounds per square inch being exerted in an operation, and also to give the gross tonnage under which the machine is operating. An automatic relief valve may be set for a maximum pressure. The cylinders have a 4-inch bore, and the stroke of the machine is suitable for a broach 52 inches long. The weight of the machine equipped with a motor is approximately 4700 pounds.

The third machine brought out by this company is a small vertical hydraulic press intended for broaching, assembling, pressing in bushings and arbors, and general operations requiring a pressure up to 2 tons or a little over. This machine is illustrated in Fig. 3. It has a stroke of 13 inches and a ram diameter of 2 inches. A dial, graduated in pounds up to 4000, is placed in a convenient position for observation by the operator. The speed of the ram, the ram movement, and the amount of pressure are controlled by the operator through a lever. The ram speed varies from 0 to 20 feet per minute. An automatic stop is provided for regulating the length of stroke. Two springs automatically return the ram to the starting position after each downward stroke.

The cylinder is 4 inches in diameter and contains the conventional type of piston. The pump is of a continuous-flow type and is controlled by a valve

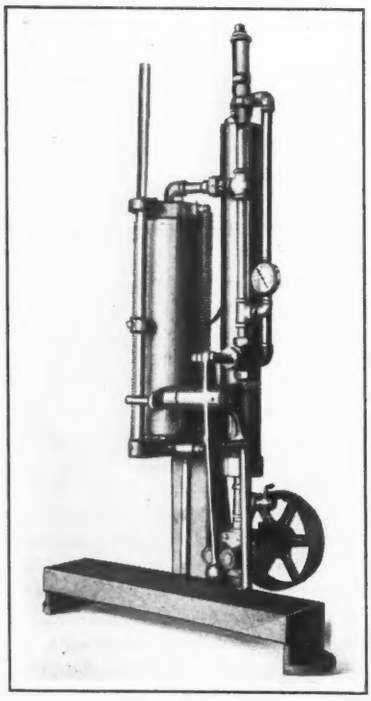


Fig. 3. Vertical Bench Broaching Press

connected with the operating lever. When the machine is not in operation, the oil flows through the control valve and returns to the tank above the pump. The pump is capable of exerting a maximum pressure of 600 pounds per square inch. A relief valve is set to operate at a pressure of 400 pounds per square inch; hence, the pump has an extra 50 per cent capacity, and does not work under full load at any time.

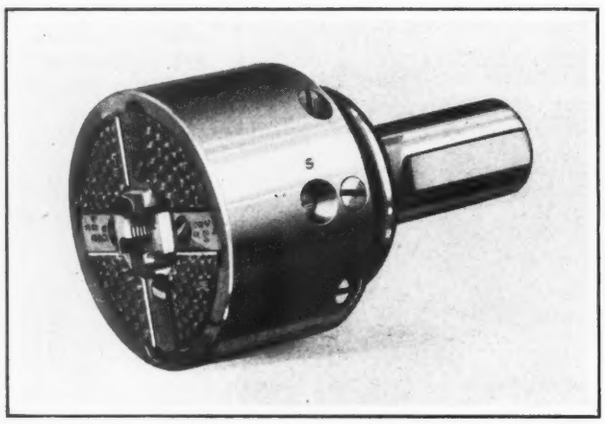
When it is desired to place the machine in some part of the shop where no bench is available, the machine can be supplied with a pedestal. An auxiliary table can also be furnished to make the machine suitable for straightening operations. With this auxiliary table, a working surface of 6 by 24 inches is available. The weight of the machine is about 375 pounds. Work up to 6 inches in diameter can be handled.

"NAMCO" SELF-OPENING DIE-HEAD

A new self-opening die-head, intended for use on multiple-spindle automatic screw machines and other equipment where a live spindle requires a revolving die, has been developed by the National Acme Co., Cleveland, Ohio. This die-head, which is known as style R, replaces the older revolving type known as "OH-64H." The style R die-head is hardened and ground throughout, and made up of only ten parts, not counting the chasers and the wrench. By the use of a screw-driver and the wrench, it is easy to take apart the die-head for cleaning or replacing parts.

The chasers are opened and closed by cams located on the inside wall of the cup or hood and, as is usual with "Namco" revolving die-heads, the opening and closing action is positively controlled by a spool on the back of the hood. The spool is an integral part of the hood, and consequently only a simple attachment in the form of a yoke fitting into the spool is required to operate the die-head on any type of machine. The adjustment of the tool to the proper cutting size is accomplished by means of two parallel screws located in the side of the hood. It is merely necessary to loosen one screw and tighten the other, and the size is shown by a micrometer reading on the hood. The adjustment can be made without removing the tool from the machine.

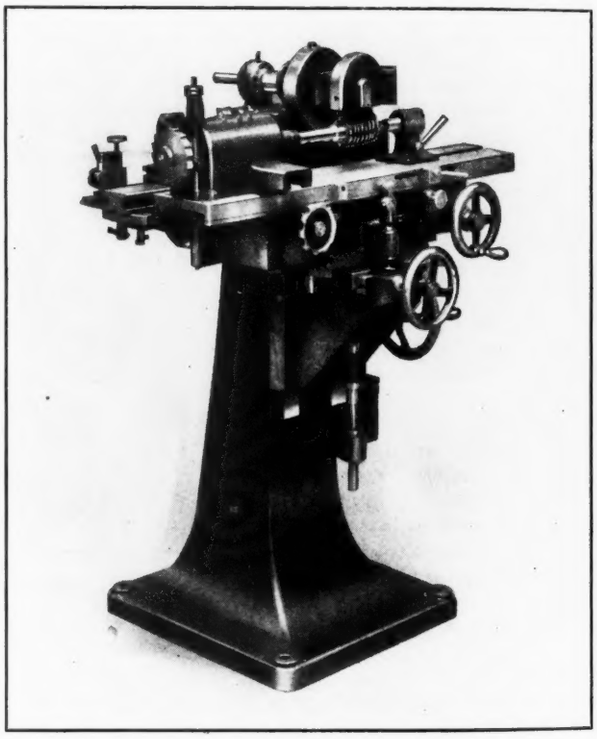
The chasers are of the overhanging type, which permits threading close to shoulders, and causes the chips to be thrown outward from the work. Chasers of other types of "Namco" revolving die-heads can be used in the new style if the size is the same. The new style is built in seven different sizes, with capacities ranging from 1/8 to 2 1/2 inches.



"Namco" Self-opening Revolving Die-head

SCHUCHARDT & SCHUTTE AUTOMATIC HOB GRINDER

A Schuchardt & Schutte automatic hob grinder is being placed on the market in this country by George Scherr, 142 Liberty St., New York City. In this machine, the table travels back and forth automatically, and the indexing of the hob is also accomplished automatically. All the operator has to do is to feed the teeth of the hob toward the grinding wheel from time to time. One operator can handle several machines, the number depending upon the size of the hobs being ground, and as the operation of the machine is simple, an unskilled operator can be employed for the work.



Automatic Hob Grinder placed on the Market by George Scherr

From the illustration it will be noted that the knee is moved vertically by means of a handwheel, and the adjustment of the cross-slide is also effected through a handwheel. The table can be moved by hand as well as automatically, the automatic traversing mechanism being engaged by means of a coupling pin in the table gear-box. By withdrawing this pin, the automatic table traverse is tripped. Stops control the length of the table movements.

As the table moves back and forth, the hob is automatically given a slight rotary motion to suit the lead of the gash. This motion is derived from a square guiding bar that is set to the helix angle of the gash. The table can be swiveled 15 degrees to the right or to the left to take care of both right- and left-hand flutes. When the guiding bar is set to zero, the table moves straight and ordinary straight-fluted cutters can then be ground.

The spiral indexing head is of a new design for which accuracy and simplicity of operation are claimed. Indexing is done by means of dividing plates, and as one plate is suitable for a number of different divisions, only a few plates are required. The cutter is fed radially toward the wheel. An

exhaust system deposits the grinding dust in a water tank and thus prevents the dust from accumulating on the accurate surfaces of this and other machines. The machine is built in two sizes to accommodate hobs up to 6 1/4 and 9 7/8 inches in diameter, respectively, and can be furnished for either a belt or motor drive.

TAYLOR & FENN DRILLING MACHINES

Type L drilling machines are now being introduced on the market by the Taylor & Fenn Co., Hartford, Conn., with any number of spindles from one to seven. The No. 1 single-spindle type equipped with a power feed is illustrated in Fig. 2, while Fig. 1 shows the No. 74 power-feed four-spindle type. These machines are intended especially for manufacturing purposes, and are therefore furnished with two pulleys only, which are made to give the spindle speeds required. Their diameters may be such as to give various speeds between 575 and 2300 revolutions per minute. By reversing the two pulleys of a machine, two spindle speeds are obtainable. A machine of this design is of advantage in

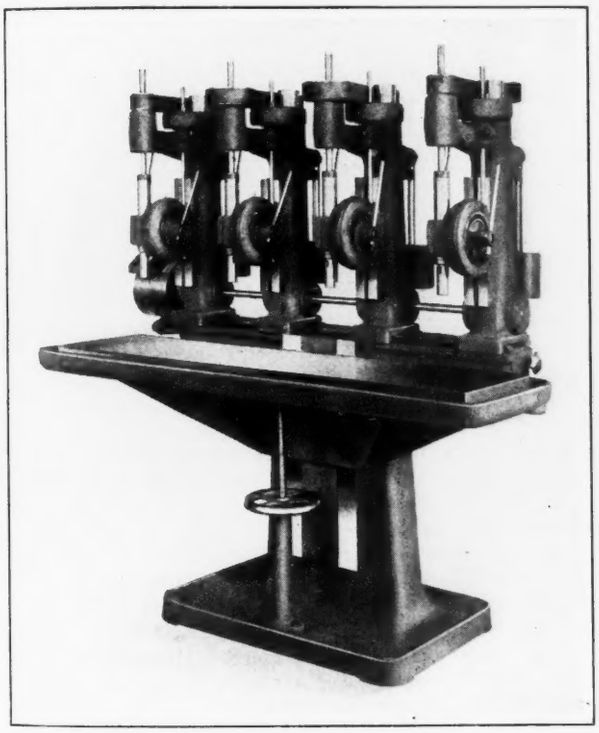


Fig. 1. Taylor & Fenn Four-spindle Drilling Machine provided with Power Feed for the Spindles

mass production because changes of speeds are infrequent. The heads are adjustable on the columns and are equipped with ball bearings throughout.

The power feed is variable from a maximum of 0.006 inch per revolution of the spindle to a minimum of 0.003 inch. The feed is regulated by the diameter of the pulley on the rear shaft and the diameter of the pulley on the spindle, because the feed is taken direct from the idler pulley. The feed is automatically increased as the spindle speed is decreased, since the ratio between the idler pulley and the spindle pulley increases as a larger diameter pulley is put on the spindle to reduce the spindle speed. A slight pressure of the drill against the work engages the power feed. It can be quickly disengaged, when necessary, before the full depth of a hole is reached, by simply lifting the hand-feed lever. It is sometimes desirable to do this when drilling deep holes. The power feed may be locked when it is preferable to feed by hand.

A motor may be mounted on a bracket attached to the rear of the column. This bracket is adjustable to take care of any slack in the belt. An oiling system is provided for the machines and tapping heads can be furnished. Some of the principal specifications are as follows: Traverse of spindle, 5½ inches; traverse of spindle bracket, 7 inches; distance from center of spindle to column, 8 inches; maximum distance from spindle to table, 25 inches; vertical movement of table, 15 inches; width of table, 16 inches; length of table, from 16 to 64 inches; and net weight of single-spindle machine, about 755 pounds. Seventy-five pounds should be added for each power-feed head, and 20 pounds for each tapping head.

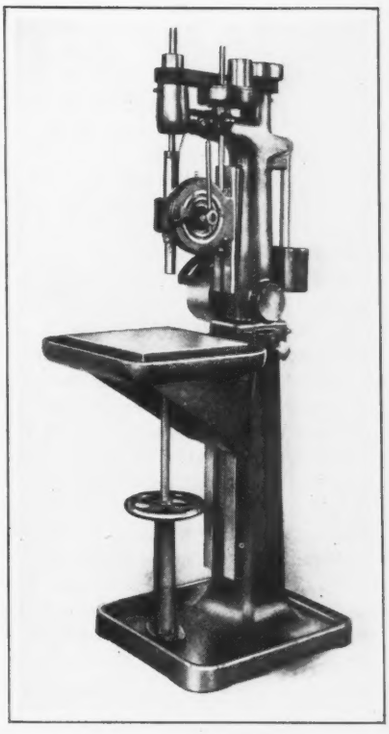
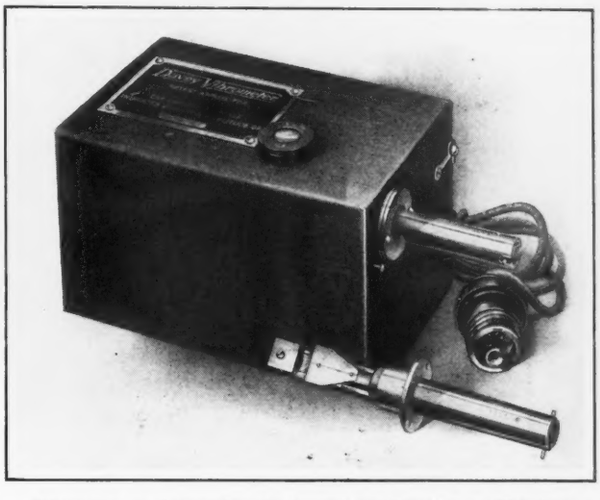


Fig. 2. Taylor & Fenn Single-spindle Drilling Machine

DAVEY VIBROMETER

The amount and direction of vibration in machinery, foundations, structures, etc., may be conveniently determined by means of a vibrometer recently developed by Peter Davey and placed on the market by E. M. Sawtelle, 11 Broadway, New York City. This device may also be used to find the critical speed of such rotating parts as turbines and to determine the state of running balance. After the amount and direction of vibration in an object have been ascertained, they can be intelligently analyzed with a view to correcting the condition.

The instrument consists of a wooden box within which scales graduated to read to 0.0005, 0.001, or 0.002 inch are interchangeable. A lever mounted in each scale assembly extends from the scale through one end of the box and forward through a protecting tube. The lever is pivoted near the outer end of the tube, and is equipped with a cross-pin near that end. The cross-pin is brought in contact with the object, the vibration of which is to be determined. On the inner end of the lever there is a black hair-line on a white background, and this hair-line moves back and forth along the graduated scale to indicate vibration in an object.



Vibrometer for determining the Amount and Direction of Vibrations

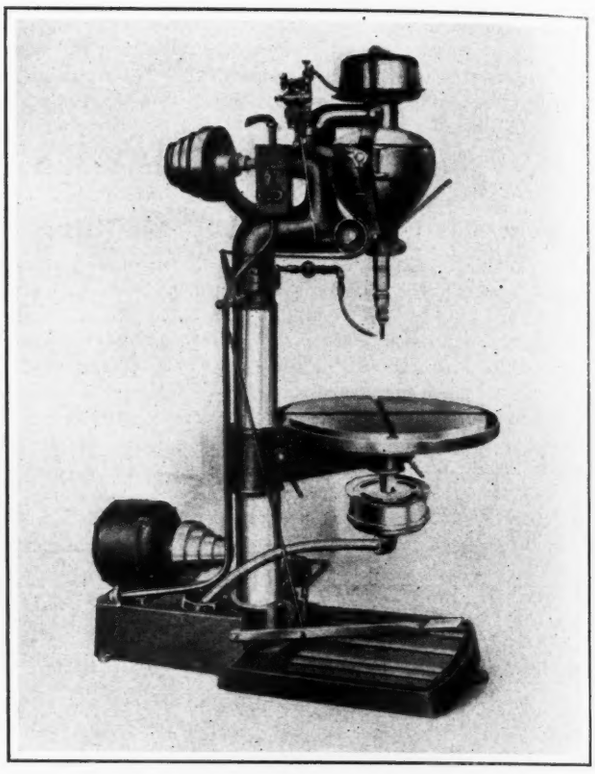
An incandescent lamp in the box illuminates the scale and hair-line so that they can be easily observed through a small microscope in the top of the box which magnifies twelve times. The ratio of the 0.001-inch lever is 8 to 1, and so any vibration in an object appears to the eye to be about ninety-six times as great as it actually is. A spring holds the lever cross-pin in contact with the object being inspected, so that the pin will exactly follow the vibratory movements. When viewed through the microscope, the vibrating hair-line appears as a black band that grows wider as the amplitude of vibration increases. From the scale it is easy to determine the width of this band, and this width represents the amount of vibration in the object. In use, the box must be supported so that it is free from the vibration being observed.

By using in the box the vibroscope lamp described in September, 1925, MACHINERY, instead of the ordinary incandescent lamp, the vibration may be analyzed completely. If the vibroscope lamp is caused to flash twice the frequency of the vibration, two distinct images of the hair-line will appear through the microscope. Thus if the vibroscope interruptor is driven direct from the shaft suspected of causing vibration and it is set to give two light flashes per revolution, a stationary double image of the line will prove the vibration to be synchronous with the shaft speed. By driving the vibroscope interruptor at various speeds until this stationary double image appears, the frequency of any vibration may be determined.

WOODWARD & POWELL CRANK PLANER

A 36- by 36-inch crank planer having a maximum stroke of 42 inches has recently been added to the line of machines built by the Woodward & Powell Planer Co., Worcester, Mass. Six table speeds of 6, 8, 12, 17, 24, and 34 strokes per minute are provided on this machine, the changes being made through a gear-box located at the front, which employs sliding gears. The length of the stroke is adjustable by means of a handwheel, and the length, in inches, is indicated by a dial adjacent to the handwheel. The position of the stroke or table relative to the cutting tool can also be adjusted so that work may be placed anywhere on the table.

The head is of the same size and design as that used on the standard 36-inch rack-driven planer built by this concern, and has the usual horizontal, vertical, and angular feeds, either by power or hand. A side-head can be furnished if desired. The cross-rail has a power elevation. The table is driven through a herringbone pinion and gear and a slotted rocker mechanism. The pin on which the slotted rocker oscillates is supported at both ends to insure a rigid construction. Either a single-pulley belt drive or a 10-horsepower constant-speed motor drive can be used.

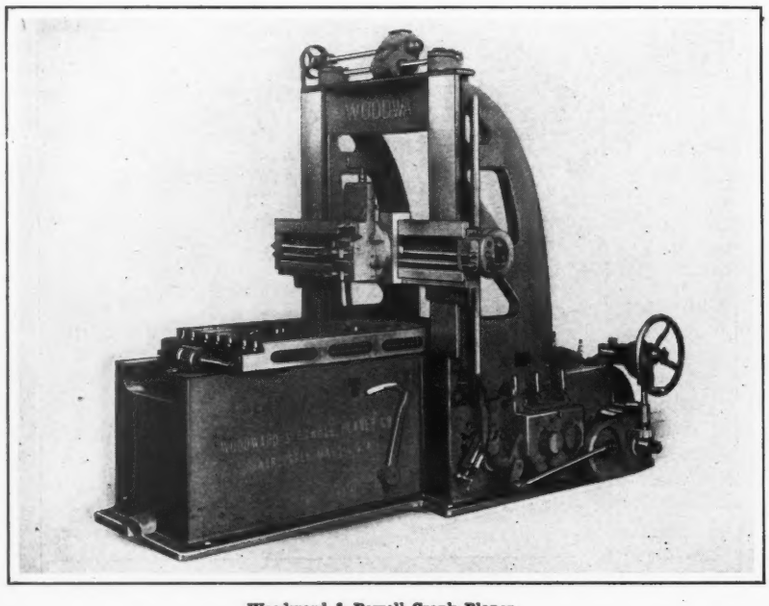


Gaterman Improved Pneumatic Oscillating Tapping Machine

GATERMAN PNEUMATIC OSCILLATING TAPPING MACHINE

An improved No. 8 pneumatic tapping machine which incorporates the automatic oscillating feature of former models, has been brought out by the W. Gaterman Mfg. Co., Franklin and 15th Sts., Manitowoc, Wis. Rotating parts that were formerly exposed are enclosed on the improved machine by guards, to prevent foreign matter from getting into the working parts and also to prevent any over-supply of oil from being thrown off the machine.

When the machine is equipped with an oil-pump, a fine wire-mesh combination strainer and chip-pan is mounted beneath the table to prevent chips, etc., from getting into the oil-tank and pump. By slightly raising the pan, it can be taken out and quickly cleaned. The tank is cast integral with the machine base and used as a mounting for the motor or countershaft, which gives a rigid construction. A hose with a blow air-gun, is furnished.

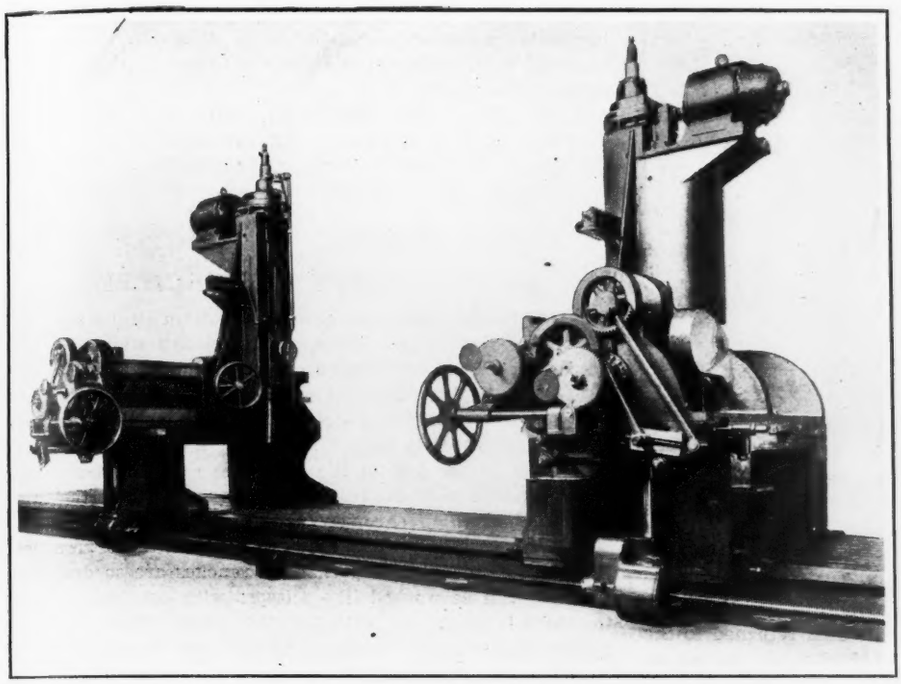


Woodward & Powell Crank Planer

BETTS LOCOMOTIVE-FRAME SLOTTER

A line of locomotive-frame slotting machines of improved design has recently been placed on the market by the Betts Machine Works of the Consolidated Machine Tool Corporation of America, Rochester, N. Y. In the illustration, one of these machines is shown equipped with two heads, but they can also be furnished with one or three heads, as required. The machines are simple in construction, and full advantage is taken of electricity for driving, feeding, and traversing the various parts. The width between the yokes, the height under the yokes, the length of the bed, and the travel of the slotting rams may be arranged to meet requirements. The height and length of the stroke may be arranged to permit the slotting of a frame in multiple.

The bed is provided with long narrow guiding surfaces for the yokes, and the faces



Betts Improved Slotter for Locomotive Frames

on which the yokes bear are chilled to give them a hard smooth surface. The top of the bed has T-slots in it for clamping the work. Both sides of the bed are equipped with stationary lead-screws on which nuts are revolved to move the yokes. The lead-screws are equipped with tumbler bearings that prevent sagging, and thrust is taken by roller bearings. Each yoke has a separate electric feed and power rapid traverse along the bed, driven by a motor mounted on the yoke. A fine hand adjustment of the yokes may be obtained through a large handwheel within reach from the floor.

The cross-rails are arranged with either a hand or power swiveling movement to permit angular slotting. Each saddle has an electric feed and power rapid traverse and a hand adjustment along the cross-rail. The motor that provides the power for the feed and rapid traverse of a yoke performs the same function for the saddle. Both the yoke and saddle feeds may be engaged simultaneously in angular slotting, and they are independent. Graduated plates, accessible from the floor, are adjusted to obtain different rates of feed.

Each ram is driven by a 20-horsepower reversing motor having a high return speed. The cutting and return speeds are independently adjustable by means of rheostats, which give a wide range of speeds. The rams are counterbalanced by means of sliding weights suspended by steel cables, and are self-contained. They are equipped with a mechanical knock-out device that prevents over-travel. The length of stroke is adjustable by means of dogs that actuate a master switch controlling the driving motor.

Ample lubrication is supplied to all bearings, the important saddle bearings being furnished with oil by an adjustable automatic pump. A push-button control for starting, stopping, reversing, "inching," etc., is available for all motors.

WESTINGHOUSE QUICK-BREAK SWITCH

A switch that is externally operated, totally enclosed, and has a simply constructed quick-break mechanism has recently been brought out by the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. This switch (type WK-62) is intended for industrial and other applications where a disconnecting switch is desired. The stops that limit the travel of the switch arm and the blades are placed on the outside of the box, which simplifies the construction and affords ample room for wiring. Easily removed knock-outs are provided in the back, sides, and top and bottom ends for any desired arrangement of the conduit. The diamond-pointed jaw and the extended blade construction are used. With this feature, any burning that occurs when the switch is opened does not foul the current-carrying area of the blades and break the jaws. The new switch is supplied in capacities of from 30 to 200 amperes, and is rated at 250 volts direct current and 250-500 volts alternating current, in both the fusible and non-fusible types.

LEAD-SCREW CONTROL FOR CLEVELAND AUTOMATICS

A lead-screw mechanism applicable to automatic screw machines for use in cutting screw threads to a lead that is accurate to a high degree has recently been developed by the Cleveland Automatic Machine Co., Cleveland, Ohio. This mechanism, in combination with change-gears, provides for the rapid handling of a range of precision threaded work. The accompanying illustrations show a model B machine equipped with this lead-screw arrangement and a magazine feed for handling cylinder-head studs. With minor modifications, the same arrangement could be applied to other sizes of machines for a wide range of forms and sizes of work.

Threading die-head *A* is carried on the tailstock spindle *B*, and at the rear end of this spindle, there is secured a carrier which has split nuts *C* for engaging lead-screw *D*. When spindle *B* has advanced die-head *A* to the work through the customary cam mechanism, a cam closes nuts *C* on the lead-screw. The rotation of this screw by means of the change-gears then causes nuts *C* and spindle *B* to feed the die-head

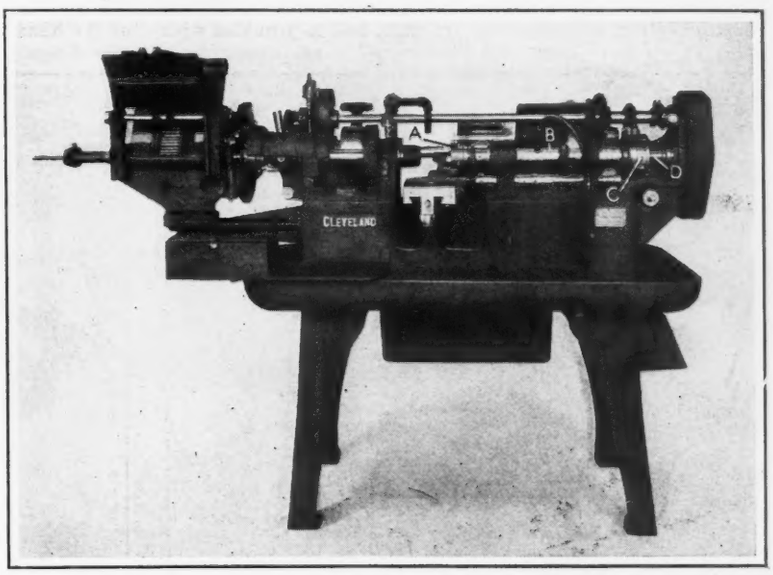


Fig. 1. Cleveland Automatic equipped with a Lead-screw Control Mechanism and Magazine Feed

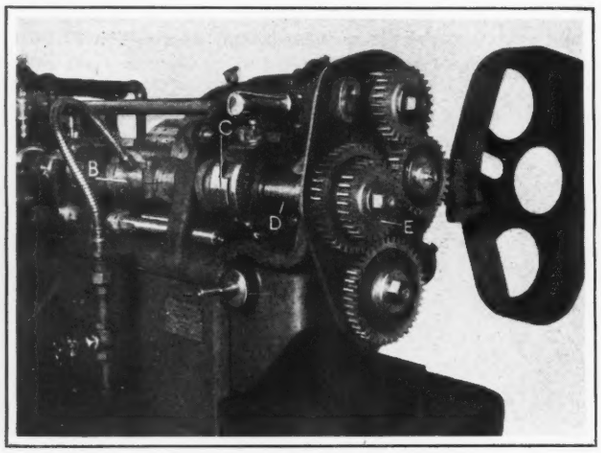


Fig. 2. Close-up View of the Lead-screw Control Mechanism and Change-gears

on the work. After the threading has been completed, the die-head is automatically tripped, and at the same time, an action in the split-nut carrier withdraws the half nuts *C* from the lead-screw. The tailstock spindle *B*, together with die-head *A* and the split-nut carrier, is then returned to the starting point. Threads of any desired pitch can be cut by transposing the change-gears shown at *E*.

WINTERHOFF PORTABLE MACHINES

A No. 1 portable universal saw and sander recently brought out by the Winterhoff Tool & Machine Co., Elkhart Ave. and Jackson St., Elkhart, Ind., is shown in Fig. 1. This machine is equipped with a 6-inch general-purpose saw, an 8-inch sanding disk, and a 6-inch tool grinding wheel. The saw, disk, and grinding wheel are driven by a 1/4-horsepower motor, the saw running at 3500 revolutions per minute and having ample power for cutting a board 1 1/4 inches thick. The saw table may be raised or tilted, and measures 10 by 12 inches. It is provided with a groove that accommodates a protractor cut-off guide, and an adjustable rip guide is also furnished which may be used on either side of the table. An automatic shutter guard protects the saw. The sanding disk is also provided with a tilting table on which there is a groove for attaching a protractor guide, while a rest is furnished for the tool grinding wheel. This machine is also built in a plain model without the sander or grinder.

Fig. 2 shows a No. 2 portable tool and disk grinder made by the same company. This equipment is also driven by a 1/4-horsepower motor having a built-in switch. The tool grinding wheel is 6 inches by 1/2 inch, and is provided with a guard and tool-rest. The disk wheel is intended for grinding metal parts, and is 8 inches in diameter. It is also equipped with a tilting table similar to the one on the machine shown in Fig. 1.

A No. 1 portable grinder is also built by the Winterhoff Tool & Machine Co., which is similar to the one shown in Fig. 2 with the exception that it is equipped with two 6-inch tool grinding wheels, guards, and rests.

BONNEY TAPPET WRENCH SET

A set of eight double-end chrome-vanadium steel wrenches, designed especially for adjusting automobile and motor truck valve tappets, is being placed on the market by the Bonney Forge & Tool Works, Allentown, Pa. In this set there are two each of four different sizes of wrenches, as the wrenches are generally used in pairs. The set is suitable for the valve tappets of 70 per cent of the passenger cars and trucks on the market. One of the features of the wrenches is the thin construction which chrome-vanadium steel makes possible.

As many cars and trucks require the use of three wrenches in the adjustment of tappets, the wrenches are so designed that two can be worked like scissors with one hand, while the third is being used with the other hand. This is accomplished by having two openings of the same size at different angles in each wrench. The wrenches are packed in a japanned metal container having a hinged top.

GEOMETRIC ADJUSTABLE COLLAPSING TAPS

A new line of adjustable collapsing taps has recently been developed by the Geometric Tool Co., New Haven, Conn., designated as classes S, SA, SB, and SC. As illustrated in Fig. 1, the class S tap is of the hand machine type, and is equipped with a handle *A* on the closing sleeve *B*, and a trip-plate *C*. When the trip-plate comes in contact with the work at the proper time, the chasers collapse. Resetting of the chasers is accomplished by hand. The class SA rotary tap of this line is the same as the class S, except that it is not provided with the closing handle. In this case also, the chasers are collapsed by a trip-plate that comes in contact with the work, but to reset the tap, a contact must be made with the back face of the closing sleeve.

Fig. 2 shows the class SB rotary tap, which is also the same as the class S tap, except that it is not provided with either the closing handle or the trip-plate. Instead, a flange *D* is fitted over the closing sleeve for the purpose of collapsing and resetting the tap. The fourth, or class SC tap, is of the hand trip type. It is equipped with a handle for the

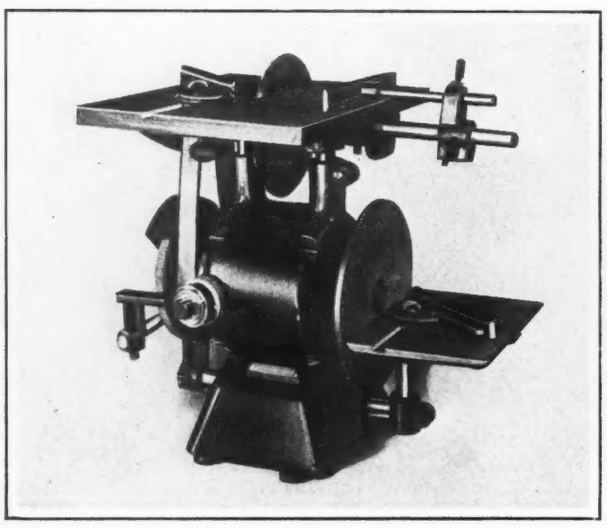


Fig. 1. Winterhoff Portable Universal Saw and Grinder

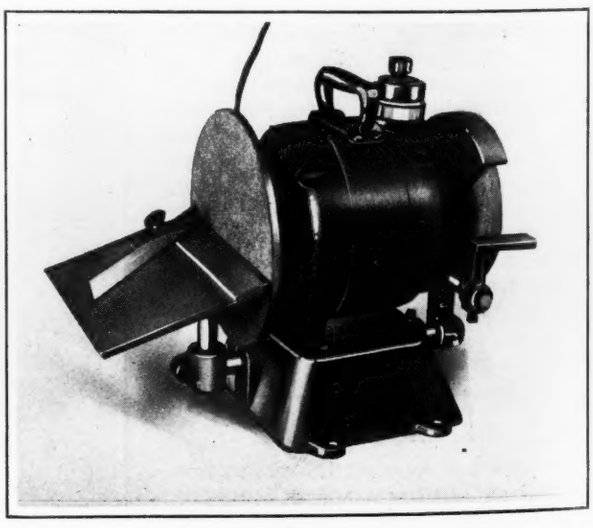


Fig. 2. Portable Equipment with a Tool Grinding and a Disk Wheel

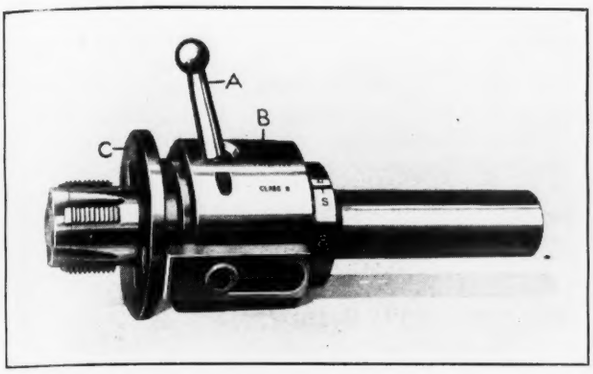


Fig. 1. Geometric Hand Machine Tap with Trip-plate and Closing Handle

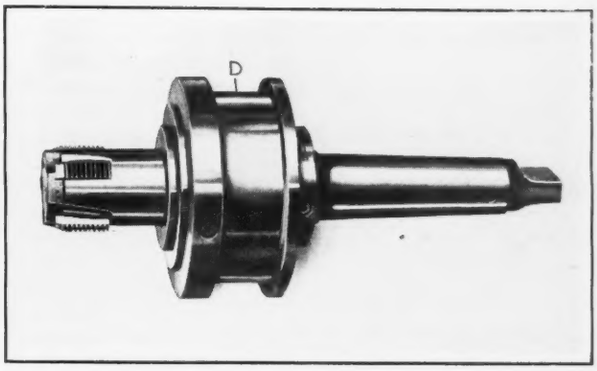


Fig. 2. Geometric Rotary Type of Tap with Flange for Collapsing and Resetting

closing sleeve, but does not have the trip-plate, and so the tap is both opened and reset by means of the handle. In all other respects it is a duplicate of the class S tap.

Any class of this line of taps is readily convertible into another class, and so one tap can be used on both hand or automatic machines by making slight changes. The chasers have been made short with a view to adding strength to the front end of the taps, and clearance grooves milled in front of the chasers, prevent the packing of chips. When it is desired to tap to a bottom, projecting chasers are used. The taps are completely enclosed and protected against dirt and chips. They are made in various sizes from 3/4 to 3 1/2 inches, inclusive.

GENERAL ELECTRIC MAGNETIC SWITCH

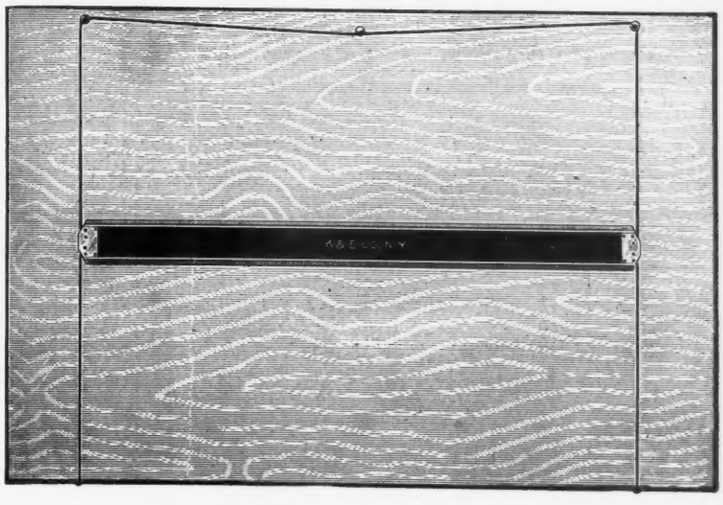
An enclosed magnetic switch intended for woodworking applications where frequencies higher than 100 cycles are necessary has been placed on the market by the General Electric Co., Schenectady, N. Y. A special coil and magnet frame construction is used without increasing the over-all dimensions. The rating of this switch, which is designated as CR-7006-S-3, varies according to the frequency of the circuit on which it is used: At 120 cycles, it will be operated on 220 volts; at 150 cycles, on 275 volts; at 180 cycles, on 330 volts; and at other frequencies on proportionate voltages. The switch is built in a two-pole form for the convenience of machine builders in conserving space and providing one disconnecting switch for all motors.

JACOBS PARALLEL STRAIGHTEDGE

A parallel straightedge recently designed by A. P. Jacobs is being placed on the market by the Keuffel & Esser Co., 127 Fulton St., New York City. Several advantages claimed for this straightedge are that it may be secured to any drawing-board that is longer than the straightedge; it may be quickly transferred from one drawing-board to another; it does not project beyond the end of the drawing-board, and thus cannot be accidentally struck by anyone passing; and it can be set up to operate on any particular part of a large drawing-board, leaving the remainder clear for other work.

The straightedge is rapidly fastened to drawing-boards by means of four special tacks and one thumb-tack. Except for these five tacks, the straightedge is self-contained, with the necessary pulleys housed between nickel-silver end plates. These plates are put above and below the cord to preclude any possibility of the cord jumping off the pulleys. The special tacks have a shoulder beneath the head which forms a groove for the cables to move in.

Adjustment of slack in the cables is accomplished by moving the tack in the center of the board at the top. The cables are made of sixteen copper strands, and pass from one end of the straightedge to the other through a conduit formed within the blade, with the result that neither the cable nor the pulleys can interfere with the operations of the draftsman. The body of the straightedge is formed of bakelite, and both edges are lined with transparent xylonite. The device is available in lengths of 42, 60, and 72 inches.



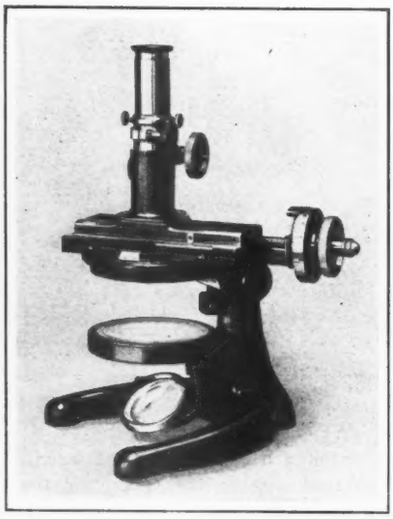
Jacobs Straightedge which may be rapidly attached to Drawing-boards

SOCIETE GENEVOISE MEASURING MICROSCOPE

A micrometer microscope of the Fraunhofer type, which is especially suitable for measuring the lead and diameters of small screws, the diameter of holes, and other dimensions of small tools and parts, has recently been brought out by the Société Genevoise d'Instruments de Physique, Geneva, Switzerland. The instrument is being placed on the American market by the R. Y. Ferner Co., Investment Bldg., Washington, D. C. It may also be used for examining the characteristics of metallurgical samples and the deformations of test pieces, as well as for many other purposes.

Angular as well as linear measurements can be made, the microscope tube being mounted in a slide, which, in turn, is supported by a rotary table. The angular position of this rotary table is read by means of a vernier graduated to 10 minutes. The slide is moved by a micrometer screw, the head of which has a vernier that may be read to either 0.001 millimeter or 0.00005 inch. Different-pitch micrometer screws, of course, are used for the metric and inch instruments.

A reticle of two crossed spider threads at an angle of 60 degrees is provided in the field of the eye-piece for use in making the settings. This reticle is adjustable transversely relative to the axis of the micrometer screw, which makes it possible to set the intersection of the threads in the center of rotation of the circular table. This provision for rotating the circular table to carry the slide and microscope to any position facilitates measuring the dimensions of small objects



Societe Genevoise Measuring Microscope

without moving the object carefully to a required position.

The working distance of the objective regularly furnished is 1 1/2 inches. A rack-and-pinion mechanism provided for focussing the instrument allows the objective to move from 1 to 2 1/2 inches above the glass plate that supports the objects. This permits measurements upon the surface of objects up to 1 inch thick; however, larger objects can usually be measured by tilting the table on which the tube is mounted through 90 degrees, so as to point the microscope tube horizontally. Then the vertical face of objects can be measured. The maximum height of the instrument is 12 inches, and the net weight, about 15 1/2 pounds.

MURCHEY REVOLVING DIE-HEAD

An improved type 0 revolving die-head has recently been brought out by the Murchey Machine & Tool Co., 34 Porter St., Detroit, Mich., for use in any style of automatic machine, the spindle of which revolves. This die-head is shown in Fig. 1, closed for cutting a thread, and in Fig. 2, set for removing the chasers. The design is such that the chasers can be readily removed without taking off the cap or removing the die-head from the spindle of the machine. The chasers can be removed without the use of a screwdriver, by simply removing a spring stop-collar from in front of the adjusting ring, so as to allow the shell to slide back, as shown in Fig. 2.

In replacing the chasers, it is only necessary to insert each one in its proper slot, press it down against a locating pin, bring the shell forward, replace the spring stop-collar, and the die-head is ready for use. It is said that the chasers can be changed in less than one-half minute. The body has been made shorter than in the previous model. A trip provided on the machine opens the die-head, and it is closed by a yoke when the spindle is returned.

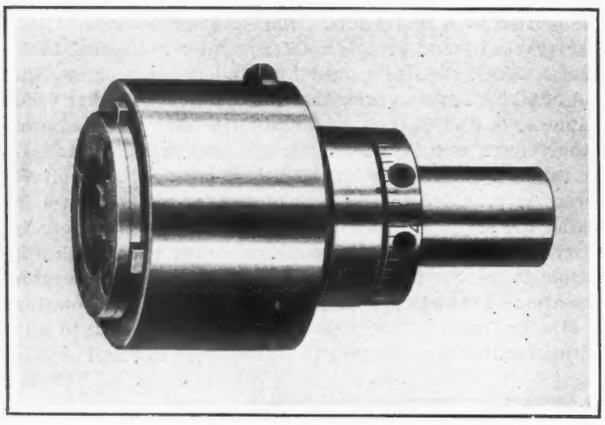


Fig. 1. Murchey Revolving Die-head of Improved Design

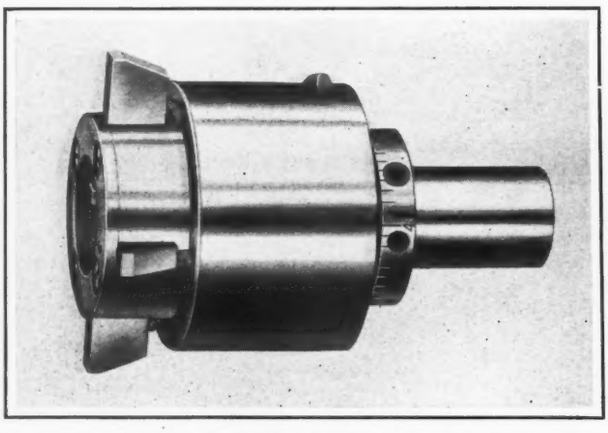
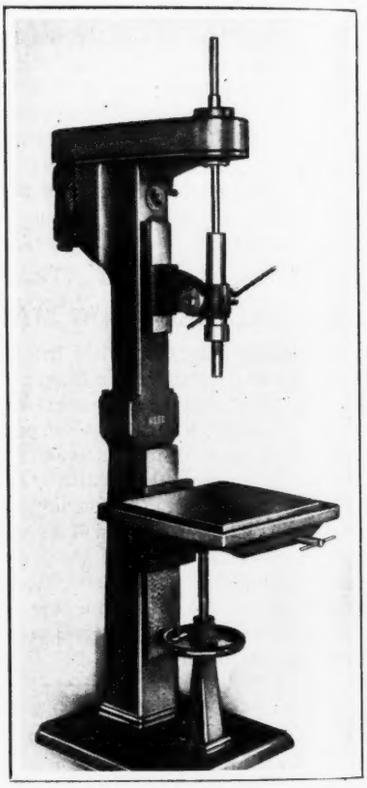


Fig. 2. Shell of Die-head slid back to permit Removal of the Chasers

REED SENSITIVE DRILLING MACHINES

A line of ball-bearing equipped sensitive drilling machines made with any number of spindles up to and including six has recently been developed by the Francis Reed Co., 41-43 Hammond St., Worcester, Mass. The single-spindle style is shown in the accompanying illustration. The drive is through one straight endless belt, which is automatically tightened to give a constant tension, sensitivity, and motor protection. The standard machine has four speeds, two of which are obtained electrically and two mechanically, the speed range being from 700 to 3600 revolutions per minute. Special cone pulleys can be furnished for nearly any desired speed. The drive is especially adapted to a single-purpose, single-pulley drill in that any speed may be obtained for a given high-production operation. The drive is wholly enclosed and readily accessible.



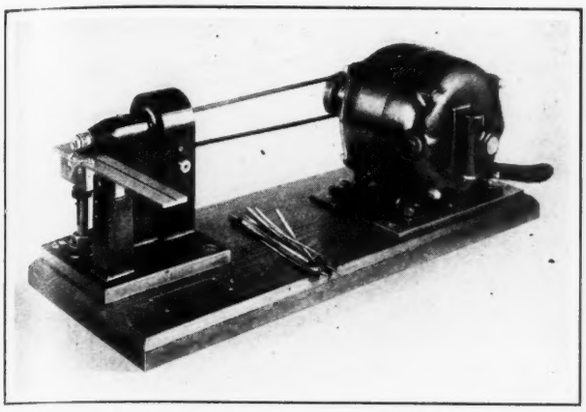
Reed Single-spindle Drilling Machine

The built-in individual motor is provided with a self-contained switch which is operated from the front of the machine. A dial indicates the speed at which the machine is being operated. The motor develops ample power for drilling 5/8-inch holes. Alternating-current, three-phase, 60-cycle motors are available for 110-, 220-, 440- and 550-volt current, and special applications can be arranged for single-pulley drives.

One of the features claimed for this line of machines is simplicity of construction. In this connection it is pointed out that there are only nine ball bearings, including those in the motor, for each spindle unit. On machines having a multiple number of spindles, all spindle units are mounted on one base, and the minimum center-to-center distance between the spindles is 10 inches. The machines have a swing of 16 inches, and the quill, a traverse of 6 inches. The spindle is provided with a No. 2 Morse taper socket.

NOBLE & WESTBROOK STRIP MARKING MACHINE

A motor-driven machine designed especially for marking strips of gold solder has recently been built by the Noble & Westbrook Mfg. Co., 19 Asylum St., Hartford, Conn. The machine rapidly produces a continuous mark along the strips to designate the grade of solder. Each strip is fed between



Noble & Westbrook Marking Machine for Strip Stock

two rolls, the top roll being provided with the proper letters, and the bottom roll grooved to carry the stock centrally. In place of the hand-crank and gears provided on a previous model, this machine is operated through a worm-gear and V-pulley driven by a 1/4-horsepower motor.

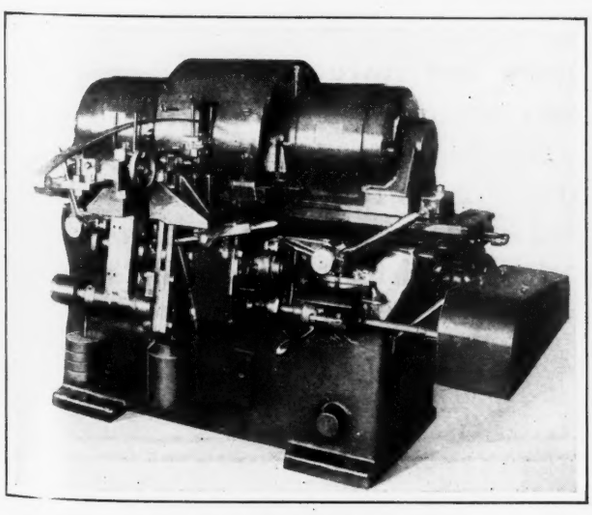
Provision is made for taking care of different thicknesses of stock. The machine runs continuously, and thus all that is required of the operator is to keep feeding the stock. The complete machine and motor weighs approximately 30 pounds.

BADGER SPRING GRINDING MACHINE

A grinding machine, especially built for grinding the sides of leaf spring eyes, has recently been developed by the Badger Tool Co., Beloit, Wis. The machine grinds the eyes to size and parallel. The spring-holder is constructed in the form of a ram, which carries the spring in between the grinding wheels and returns it, after which it stops for reloading. The grinding heads open as the spring enters and then close until stopped by a micrometer stop-screw. The various motions are automatic and power-actuated.

The grinding heads are opened by means of cams driven from a reduction gear-box. The cams act on roller levers which are connected to the grinding heads by means of a rack and pinion. Weights supported on arms at the rear of the machine bring the heads together.

One of the special features of the machine is the means for actuating the work-holding fixture or ram. The ram is traversed between the wheels by means of a weight and lever, and is brought back into the loading position by means of a double cam driven through reduction gears. One of the ram-operating cams provides a constant short stroke while the spring eye is between the grinding wheels. The tripping of the hand-lever shown at the front of the gear-box causes the ram to back out automatically from between the wheels and stop. With this control, it is possible to have the ram make one pass only between the wheels, or reciprocate for any given length of time. In this way, the number of passes between the wheels is always under control, and it is possible, by varying the number of passes, to produce a spring eye finished to very accurate dimensions.



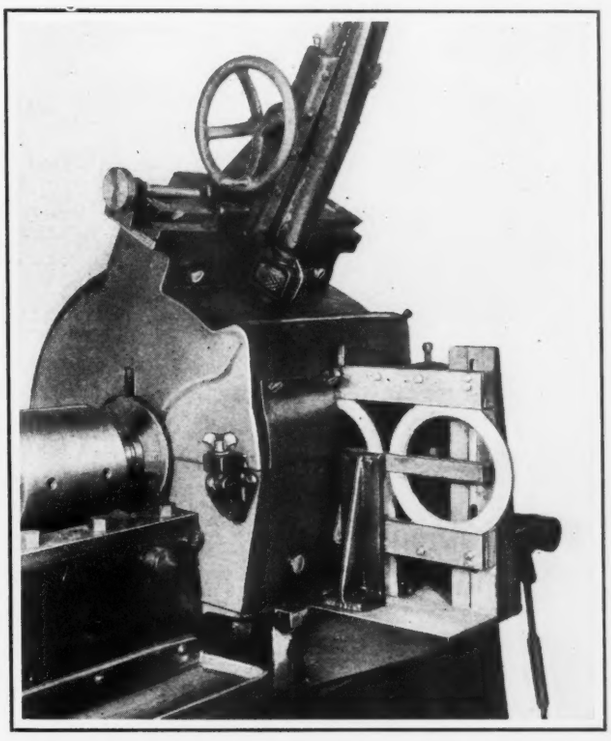
Badger Leaf Spring Grinding Machine

The machine is provided with two built-in 10-horsepower motors for driving the main spindles, and a separate 1-horsepower motor for operating the ram mechanism. The grinding members are abrasive cylinder wheels, 18 inches in diameter by 1 1/2 inches face, held in chucks. The wheel dresser may be mounted either at the front or rear of the machine. Separate micrometer stop-screws are provided for each head to compensate for uneven wear of the cylinder wheels. The machine may also be built for belt drive, and may be arranged for either wet or dry grinding. It weighs, complete, 4500 pounds, and requires an operating floor space of 8 by 11 feet.

* * *

GRINDING ASBESTOS CLUTCH RINGS

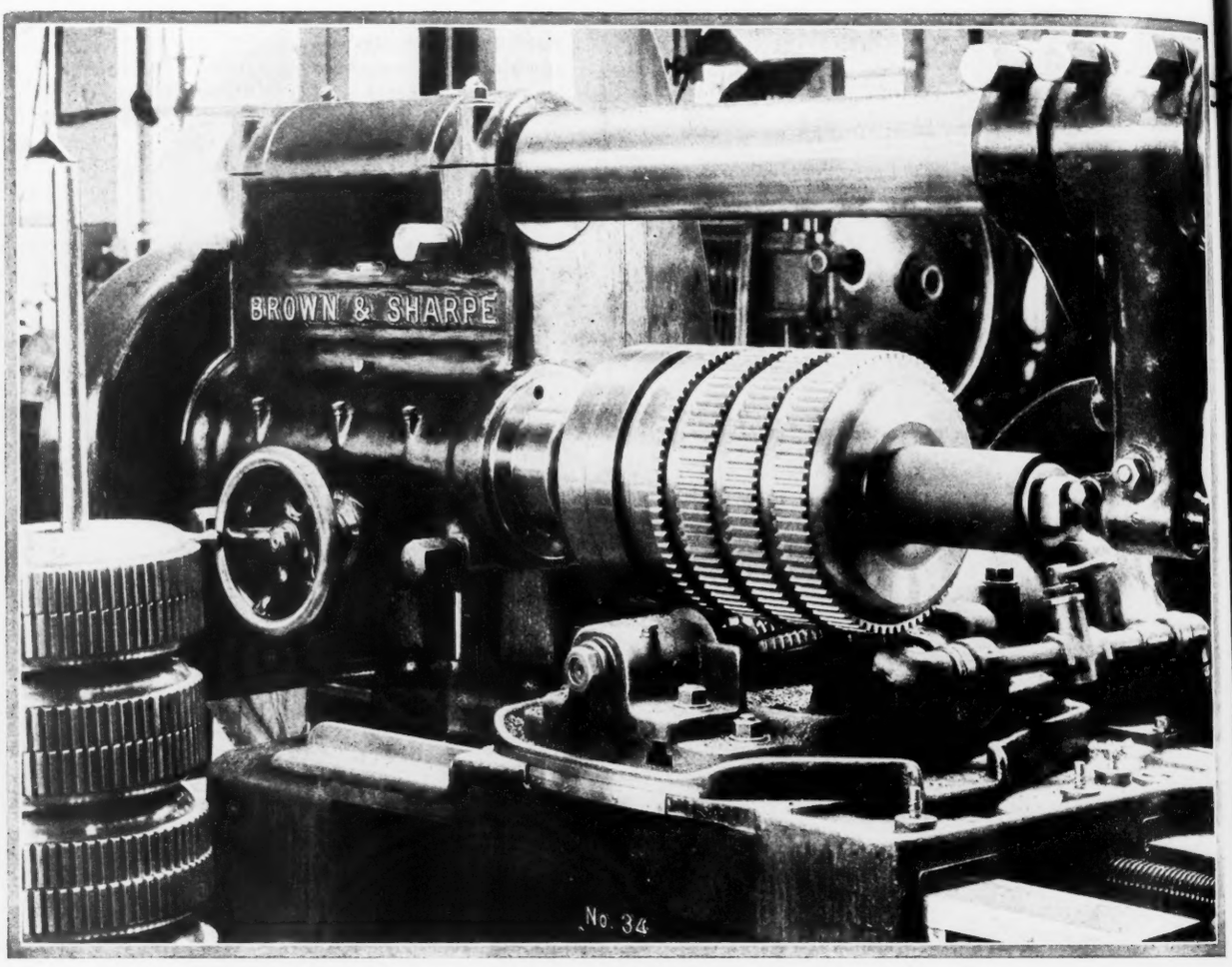
The sides of asbestos clutch rings are being ground parallel and to the proper thickness in a double-spindle disk grinding machine, arranged as shown in the accompanying illustration. On one ring, which is 9 3/4 inches outside diameter and 6 3/4 inches inside diameter, from 0.020 to 0.030 inch of stock is removed. On this operation, the machine grinds an average of 400 rings per hour, holding the sides parallel within 0.004 inch and the rings uniform within 0.005 inch.



Grinding Both Faces of Asbestos Clutch Rings Parallel and Accurate as to Thickness

The machine is a special No. 14 grinder built by the Gardner Machine Co., 414 E. Gardner St., Beloit, Wis. It has two opposed grinding heads, which are each equipped with a 20-inch steel disk wheel. Both heads are movable and have a micrometer adjustment. They are held stationary by spring tension during the grinding operation. The grinding members are heavy abrasive disks, held by a special bond suitable for asbestos.

The special work fixture consists of steel guide bars which pass between the opposed grinding members and are rigidly supported at the front and rear of the machine. The clutch rings are fed by hand through this fixture, as the flexibility of the material does not permit an automatic feed. A special wheel-dressing device is mounted on the machine hood.



Putting weight where weight is needed reduces chatter and saves Hobs

BROWN & SHARPE Gear Hobbing Machines are built heavily enough to practically eliminate chatter. The hob runs smoothly on its spindle, cutting accurate, quiet gears.

Better gears are only one advantage of chatterless operation. The hob itself is protected by this inbuilt ruggedness. It retains the accuracy of its tooth-form, stays sharp longer, and ***lasts*** longer when protected from the relentless punishment it would receive on a chattering machine.

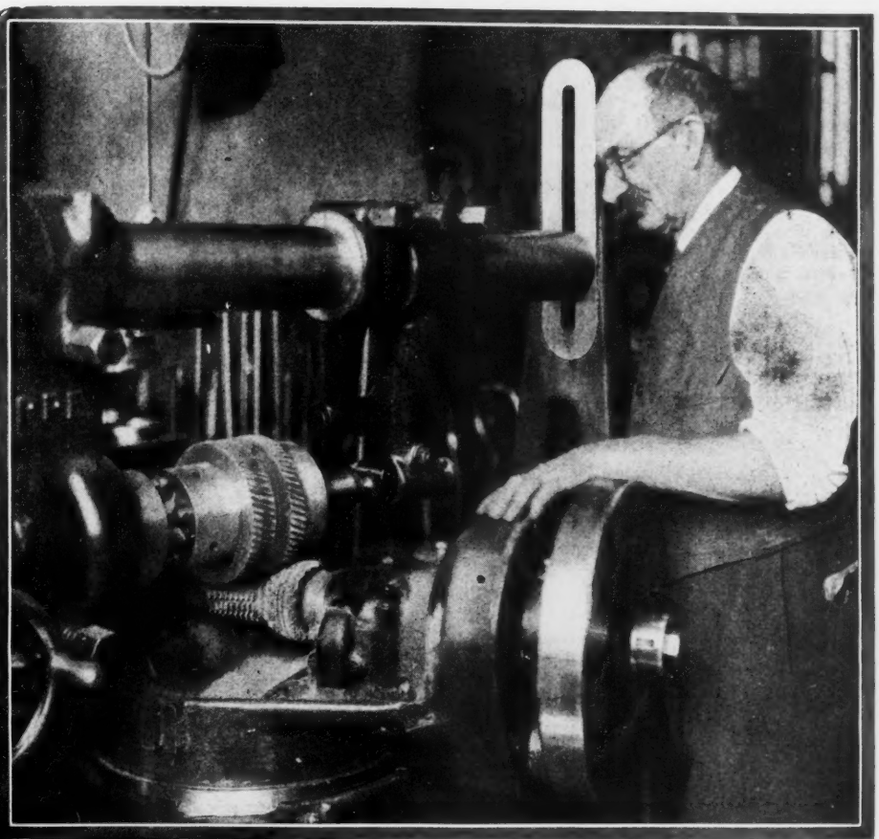
Note these examples of weight placed were weight is needed

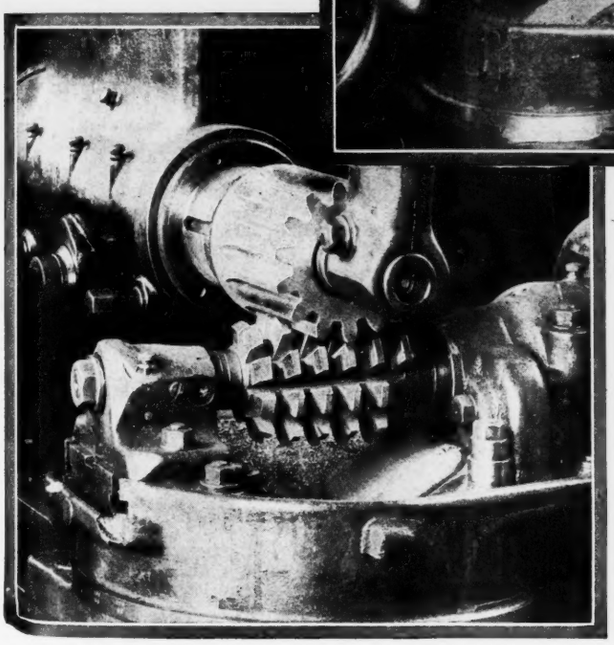
The massive frame
The sturdy work spindle
The rugged overarm
The stanch arbor support
The heavy balance wheel
The sturdy hob slide

Right—Cutting Spiral cam shaft gears on a No. 44 Brown & Sharpe Spur and Spiral Gear Hobbing Machine. Gears of any ordinary material can be cut rapidly and accurately on either of these machines.

Left—The view on the left hand page shows a gang of six cast iron spur gears being hobbed on the Brown & Sharpe No. 34 Spur Gear Hobbing Machine.

Below—A large cast iron pinion being cut on the No. 44 machine. Both machines are readily adaptable for cutting gears singly.





Any manufacturer who "knows the costs" in his gear department will readily admit the cost-shearing advantages of hobbing with Brown & Sharpe Machines. Both the No. 34 for Spur Gears and the No. 44 for Spur and Spiral Gears, are rugged, accurate, and easily operated.

Install one of these machines in your shop. Use it for "hogging" out gears in gangs or cutting them singly. You will find Brown & Sharpe Gear Hobbing Machines the safest insurance of better gears at a profit.

BROWN & SHARPE

BROWN & SHARPE MFG. CO. PROVIDENCE, R. I., U. S. A.

Send for this booklet.

As a first step toward lower costs in your gear department, send for "Brown & Sharpe Gear Hobbing Machines," a practical well-illustrated booklet describing the No. 34 machine, for Spur Gears, and the No. 44 machine, for Spur and Spiral Gears.

PERSONALS

G. L. HULBEN has joined the sales force of the Chicago branch of the Ludlum Steel Co., Watervliet, N. Y.

JOHN W. GREENE has been appointed to a newly created research fellowship to study the "reactivity" of coke at the Carnegie Institute of Technology, Pittsburg, Pa.

GEORGE M. PEARSE, for many years western representative of the Brown & Sharpe Mfg. Co., Providence, R. I., has been appointed sales manager of the Union Twist Drill Co., Athol, Mass.

J. B. JAMISON, formerly Pittsburg sales manager for the Union Drawn Steel Co., is now associated with the Standard Steel Specialty Co., Beaver Falls, Pa., in the capacity of secretary and general sales manager.

S. A. DINSMORE, formerly Chicago sales manager for the Standard Gauge Steel Co., has become associated with the Standard Steel Specialty Co. as western sales manager, with offices at 327 S. LaSalle St., Chicago, Ill.

J. C. BANNISTER, vice-president in charge of engineering of the Walworth Co., Boston, Mass., retired from active work on January 1, and was given a farewell dinner by his associates at the Harvard Club in Boston on December 21.

JOHN ANDREWS, JR., formerly manager of the Cleveland branch office of the Westinghouse Electric & Mfg. Co., has been made manager of the Detroit district office, effective January 15. He succeeds C. C. OWENS who has resigned.

ARTHUR G. HENRY, formerly metallurgist with the Perfection Tool Hardening Co., has joined the Danly Machine Specialties, Inc., 4907 Lincoln Ave., Chicago, Ill. Mr. Henry will serve as chief metallurgist at the Chicago plant of the company.

F. C. HORNER has been appointed assistant to vice-president Alfred H. Swayne, chairman of the General Motors Corporation Traffic Association. Mr. Horner will be in charge of the development of the commercial motor vehicle field on steam and electric railroads.

EDWARD RIVETT, up to some years ago actively engaged in machine tool building and also active in the work of the National Machine Tool Builders' Association, celebrated his seventy-fifth birthday on January 5. Mr. Rivett now makes his home in Allerton, Mass.

EUGENE F. HARTLEY, formerly chief statistician for manufactures of the Bureau of Census, United States Department of Commerce, Washington, D. C., is now associated with the International Business Machines Corporation, 50 Broad St., New York City, as statistician.

ROBERT J. ANDERSON, consulting metallurgical engineer, has been appointed district manager of R. J. Ryan & Co., industrial heating engineers, of Philadelphia, Pa. Dr. Anderson will represent the company in Cleveland and the Ohio district and surrounding territory.

S. L. NICHOLSON was elected acting vice-president of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., at a recent meeting of the executive committee. Mr. Nicholson has been associated with the Westinghouse company since 1898, and has been assistant to the vice-president since 1917.

W. J. FOSTER, who has been assistant engineer in the alternating-current engineering department of the General Electric Co., Schenectady, N. Y., since 1892, has been made a consulting engineer of the department. He will also serve the other engineering departments, as well as the commercial departments, in a consulting capacity.

EARL S. HENNINGSEN and P. L. ALGER have been made assistant engineers of the alternating-current engineering department of the General Electric Co., Schenectady, N. Y. Mr. Henningsen will devote his attention primarily to administrative and mechanical problems, and Mr. Alger will have general responsibility for electrical designs and investigations.

W. W. NICHOLS, mechanical engineer with D. P. Brown & Co., 1436 Park Place, Detroit, Mich., manufacturer of belting and transmission appliances, has been made assistant to W. R. Brown, general manager of the company. Mr. Nichols is a former president of the Detroit Chapter of the Society of Industrial Engineers, and has taken an active part in other engineering societies.

DEXTER S. KIMBALL, Dean of the College of Engineering of Cornell University, Ithaca, N. Y., was elected president of the American Engineering Council at the annual meeting of the Council in Washington, January 13 to 15. Dean Kimball, who is a past-president of the American Society of Mechanical Engineers, succeeds former Governor James Hartness of Vermont as president of the American Engineering Council.

HOWARD U. HERRICK, formerly vice-president and general manager of the V & O Press Co., Hudson, N. Y., has been elected president of the company to succeed WILLIAM P. JEFFERY, who has resigned in order to devote his entire time to his legal profession. Previous to joining the V & O Press Co. about two years ago, Mr. Herrick was works manager of the Brown-Lipe Gear Co., Syracuse, N. Y. Mr. Herrick will also continue to serve as general manager. There is no other change in the organization.

C. G. DUNKLE, secretary of the Pittsburg Section of the American Chemical Society, and a former chemist with the H. J. Heinz Co. in Pittsburg, has been appointed to a research fellowship in mining and metallurgy at the Carnegie Institute of Technology. This appointment fills the vacancy caused by the death of Benjamin E. Hess of Los Angeles, Cal., who was killed in a train wreck near Altoona, Pa., on December 19. Mr. Dunkle will continue the investigations in a study of flame propagation in natural gas and air that were being carried on by his predecessor.

ERNEST WOOLER has been appointed chief engineer of the Timken Roller Bearing Co., Canton, Ohio, and will have charge of all automotive, industrial, experimental, and service engineering. Mr. Wooler has had a wide experience in both American and European engineering and manufacturing practice. J. W. SPRAY has been promoted to the position of manager of sales of the automotive division of the company. E. W. AUSTIN and R. W. BALLENTINE have been made assistant manager of sales of the automotive division. PETER C. POSS has been made assistant advertising manager.

DR. PARKE R. KOLB has been elected president of the Polytechnic Institute of Brooklyn. Dr. Kolb went to the Polytechnic Institute from the Municipal University of Akron, where he served as president for a period of twelve years. He is a graduate of Buchtel College and received a Master's Degree from that college in 1902. He received a Ph. D. from the University of Heidelberg in 1912. Dr. Kolb was a member of the Federal School Survey Commission to the Hawaiian Islands in 1919, and head of the United States Bureau of Education's Survey Commission to the University of Arizona in 1922. He is a frequent contributor to educational publications.

W. W. SAYERS has been appointed chief engineer of the Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill., with headquarters at the general office. This is a new position which has just been created and entails general supervision over all engineering work, harmonizing the practice of the several plants, and following up new engineering developments. Mr. Sayers has been associated with the company for the last twenty-three years. GEORGE L. MOREHEAD, for the last six years connected with the management of the several Indianapolis plants of the Link-Belt Co., has been made manager of the Philadelphia branch. Mr. Morehead has been associated with the company for the last nineteen years.

A. S. DURANT, formerly manager of the Department of the Americas of the International General Electric Co., has been made a vice-president of the company in charge of commercial relations, with headquarters in New York City. JAMES C. RYAN, formerly sales manager of the Department of the Far East, has been appointed general sales manager with responsibility for all sales of apparatus and supplies. E. A. BALDWIN, formerly manager of the Department of Europe, has been appointed manager of the Schenectady office, with general supervision of that office and responsibility for engineering and contract relations. W. J. EDMONDS, comptroller of the company, with headquarters in New York, now has executive direction of the activities, with the exception of sales effort, of the International foreign sales companies, in addition to his former duties.

* * *

WORLD MOTOR TRANSPORT CONGRESS

The second World Motor Transport Congress was held at Hotel Roosevelt, New York City, January 11 to 13 under the auspices of the National Automobile Chamber of Commerce, 366 Madison Ave., New York City. The international character of the gathering was evidenced by the fact that the program was printed in four languages—English, French, Spanish, and German. A great many foreign countries were represented by delegates. The subjects discussed related to sales organization, sales promotion, service organization, and motor bus operation.

* * *

The United States Civil Service Commission states that there is a shortage of draftsmen at the New York Navy Yard, and this yard can make use of a reasonable number of mechanical draftsmen, structural steel draftsmen, ship piping draftsmen, and ship ventilation draftsmen. Applicants will be rated on their education, experience, fitness, and specimens of their work. They should write for full information and application blanks to the secretary of the second United States civil service district, Custom House, New York City.

* * *

The silent running of micarta timing gears was demonstrated at the New York Automobile Show in January, by the Westinghouse Electric & Mfg. Co. A model of a six-cylinder passenger car motor operating with micarta timing gears was on display.

Two more reasons why operators ask for CINCINNATI MILLERS

CINCINNATI
MAKES MORE MACHINE TOOLS IN A SINGLE DAY, IT'S THAN ANY OTHER DEVOTED TO THE WORLD
TO SEE AND LET DATE MACHINE TOOL COME TO
CINCINNATI
CROSS FEED AND REVERSE
TABLE FEED AND REVERSE
VERTICAL FEED AND REVERSE

Milling completely around four sides of Drive Box on a No. 4 Vertical High Power Cincinnati Miller.

"Why hamper your Skilled Operators with obsolete equipment?"

At His Finger Tips

The operator has directional control of all movements. He shifts the lever in the direction in which he wishes the work to move—left or right—up or down—in or out—all without moving his feet. On this job, the controls alone made possible a 25% production increase.

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI·OHIO·U·S·A·

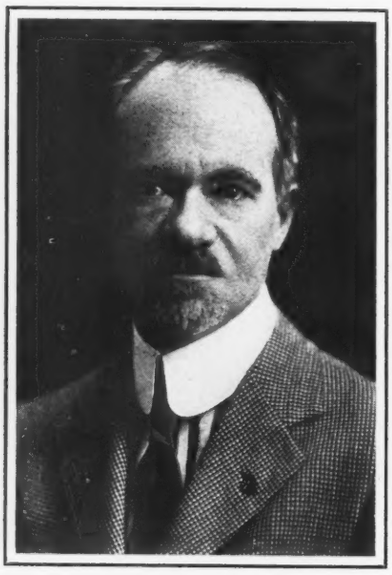
CINCINNATI MILLERS

OBITUARIES

HENRY M. NORRIS

Henry M. Norris, since 1909 secretary and a director of the Cincinnati Bickford Tool Co., Cincinnati, Ohio, died suddenly of heart failure in Cincinnati, December 24. Mr. Norris was apparently in good health and was active in his work up to the moment of his death, which came as a great shock to his many friends.

Mr. Norris was born in Trenton, N. J., January 21, 1868. He received his earlier education in the Trenton schools, and later began his mechanical career as an apprentice in Bement, Miles & Co.'s shops at Philadelphia, Pa. Later he spent a year in the drafting-room of the Phoenix Iron Co., at Trenton, N. J. Immediately afterward he entered the Sibley College of Cornell University as a special student in mechanical engineering, and from Cornell he went to the Ferracute Machine Co., Bridgeton, N. J., as draftsman. Later, he was employed by the Brown & Sharpe Mfg. Co., Providence, R. I., and by the Pond Machine Tool Co., Plainfield, N. J. In 1894 and 1895 he was superintendent and engineer for the Appleton Mfg. Co. and the Riehle Bros. Testing Machine Co. in Philadelphia, Pa. In 1896 he was general manager of the Campbell & Zell Co. of Baltimore, Md.



In 1897 he became works manager of the Bickford Drill & Tool Co. of Cincinnati, Ohio, continuing in this capacity until the formation of the Cincinnati Bickford Tool Co. in 1909, when he became secretary and a director of the new organization.

Mr. Norris was a prolific inventor in the machine tool field, and his work was especially identified with the development of the modern type of radial drill. A great many improvements in this type of machine were devised by Mr. Norris. He was one of the first to determine definitely the power required for the driving of drills under various conditions. During the war he was a member of the Council of National Defense, and served as a mechanical engineer for the Ordnance Department. He was a charter member of the Army Ordnance Association.

In 1892, Mr. Norris joined the American Society of Mechanical Engineers. He was chairman of the Cincinnati Section of the society in 1920, and a manager and member of the Council of the society from 1920 to 1923. He was also a member of the Engineers' Club of Cincinnati, of which he was a director from 1920 to 1923. He wrote a number of treatises on machine tool subjects.

CHARLES H. BAKER, who for fourteen years was in the employ of the Adriance Machine Works, Inc., Brooklyn, N. Y., as special sales representative and later as sales manager of the sheet-metal working department, died at the Irvington (N. J.) Hospital from heart failure, following a minor operation. Mr. Baker entered the employ of the Detroit Electric Works in 1890, and went from there to the Walker Electric Co. of Cleveland, Ohio. In 1900, he went to the General Electric Co. as erecting engineer, remaining there seven years. Later he entered the employ of the Crocker Wheeler Co. in a similar capacity. It was while with the Crocker Wheeler Co. that Mr. Baker met the late Colonel Benjamin Adriance who asked him to accept a position with the Adriance Machine Works, which was terminated by death after fourteen years of faithful service. Mr. Baker was sixty-six years old. He married, in 1890, Matilda Graham of Mitchell, Ontario, who survives him.

R. A. STORM, manager of the structural department of the Morgan Engineering Co., Alliance, Ohio, died on January 2 from pneumonia, after two weeks illness. Mr. Storm was born in Altoona, Pa., forty-three years ago. Prior to 1901, he was connected with the Pittsburg Steel Car Co., and in 1901 he became assistant superintendent of the structural department of the Tennessee Coal & Iron Railroad Co., Birmingham, Ala. In 1916 he joined the Morgan Engineering Co. as superintendent of the structural department. When this company started the rebuilding of locomotives, Mr. Storm was made manager of the boiler department and afterward manager of the structural department. He was well known to the fabricating trade as an authority on electric arc welding of structural steel, having spoken before different organizations on this subject.

WILLIAM ROTHEN, for twenty-three years connected with Henry Prentiss & Co., New York City, died January 13 at the Orange Memorial Hospital, Orange, N. J. Mr. Rothen was born in New York City, and after having graduated from high school, went directly into the office of Henry Prentiss & Co., and had been employed by the company since that time. After having worked a few years in the office, he became a salesman, covering that part of the New Jersey territory including Newark and Trenton and the intermediate district, for a great many years.

RICHARD E. BEBB, chairman of the Central Steel Co., Massillon, Ohio, died at the University of Pennsylvania Hospital, Philadelphia, Pa., on January 5.

TRADE NOTES

G. A. GRAY CO., manufacturer of planers, has moved into its new plant at Woodburn Ave. and Pennsylvania Railroad, Evanston, Cincinnati, Ohio.

REDFIELD, FISHER & WALLACE, INC., advertising agents, have moved to larger quarters in the Pennsylvania Bldg., 225 W. 34th St., New York City.

LAUGHLIN-BARNEY MACHINERY CO. has changed its name to the BARNEY MACHINERY CO., INC., and is located at 483 Union Trust Bldg., Pittsburg, Pa. The personnel of the company remains the same as heretofore.

GEOMETRIC TOOL CO., New Haven, Conn., has appointed the F. F. Barber Machinery Co., Ltd., Foy Bldg., 32 Front St., W., Toronto, Ontario, Canada, exclusive representative for the company in the province of Ontario.

LEIMAN BROS., dealers in machinery and tools, moved into their own building at 23 Walker St., New York City, on February 1. The building is a four-story structure, and both the salesrooms and warehouse will be located there.

STROBL MFG. CO., 1134 W. Lake St., Chicago, Ill., has been sold and is superseded by the UNIVERSAL METAL PRODUCTS CO., manufacturer of specialty hardware. The president of the company is Samuel Strobl, and the vice-president, C. G. Kronmiller.

LINK-BELT CO., 910 S. Michigan Ave., Chicago, Ill., has opened a branch office in the First Wisconsin National Bank Building, Milwaukee, Wis., to take care of the increasing demand for Link-Belt silent chain drives. R. C. Kendall is in charge of the new office.

G. K. MCMULLEN CO., 201 McMullen Building, 19-27 Division Ave., S. W., Grand Rapids, Mich., has been formed to act as direct factory representative for woodworking and metalworking machinery and accessory manufacturers. The territory covered will be western, central, and northern Michigan.

JENKINS MACHINE CO., Sheboygan Falls, Wis., manufacturer of woodworking machinery, announces that all sales of the company are now handled exclusively by the Yates American Machine Co., which is located at Beloit, Wis.; Chicago, Ill.; and Rochester, N. Y., and has branches throughout the world.

ABRASIVE CO., Bridesburg, Philadelphia, Pa., held its annual sales conference at the Philadelphia plant January 4. Edward W. Dodge, sales manager, presided at the conference sessions. The officers of the company entertained the visiting field men at dinner at the Manufacturers' Club on January 6.

LUDLUM STEEL CO., Watervliet, N. Y., is making a number of additions to its plant necessitated by the increase in business. The capacity of the billet grinding department has been doubled, and this department will be equipped with a modern exhaust system for the elimination of the dust incident to grinding.

W. A. JONES FOUNDRY & MACHINE CO., 4409 W. Roosevelt Road, Chicago, Ill., recently held its annual sales conference at the home office, which was attended by Jones sales representatives from all over the country, including New York, Buffalo, Pittsburg, Cleveland, Cincinnati, Detroit, Milwaukee, St. Louis, Peoria and Birmingham.

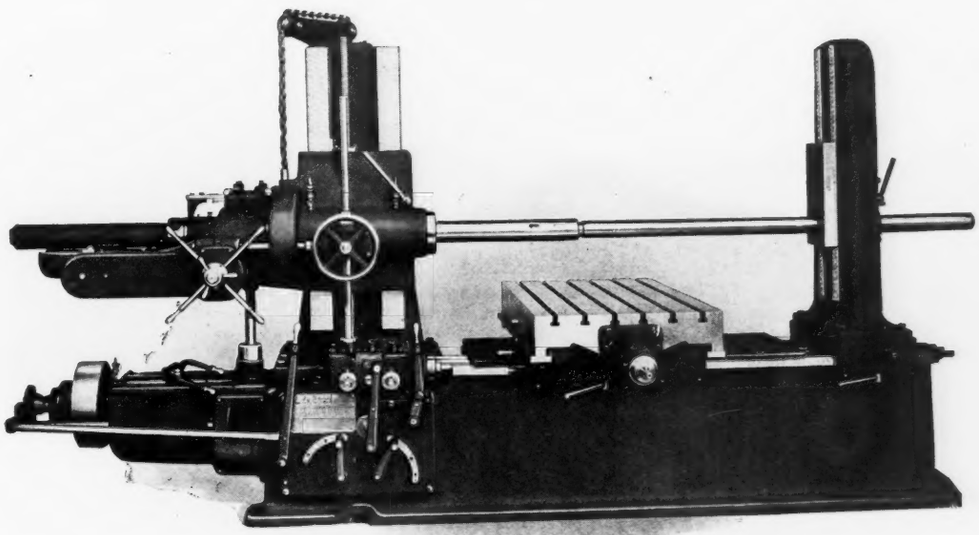
L. H. GILMER CO., Tacony, Philadelphia, Pa., manufacturer of woven belts and small rubber belts, has purchased a new factory at Wayne, Mich., a suburb of Detroit. The new plant consists of a two-story brick building, having 50,000 square

"KNOW YOUR COSTS"

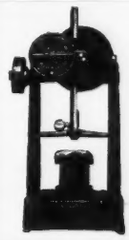
Reduce to a minimum expensive hand fitting by insuring the various units coming to the assembling department accurately machined, through the installation of a LUCAS

"PRECISION"

Horizontal Boring, Drilling and Milling Machine



An all-around Jig in itself, for a wide variety of jobs, thus saving the cost of many special jigs which would be useless for other work when their purpose had been served. If the quantity of your work warrants such special jigs, originate them on the "Precision."



WE ALSO MAKE THE

LUCAS POWER

Forcing Press

THE LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF **CLEVELAND, OHIO, U.S.A.**

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry, Societe Anonyme Belge, Alfred Herbert, Brussels. Allied Machinery Co., Turin, Barcelona, Zurich. V. Lowener, Copenhagen, Oslo, Stockholm. R. S. Stokvis & Zonen, Paris and Rotterdam, Andrews & George Co., Tokyo.

feet of floor space, located on a 4 1/2-acre tract on the main line of the Michigan Central Railroad.

NAZEL ENGINEERING & MACHINE WORKS, 4043 N. 5th St., Philadelphia, Pa., has purchased from the T. C. Dill Machine Co. all rights and titles to the Dill slotter, and will manufacture this machine in connection with the Nazel air hammer. Robert Miller, long associated with the T. C. Dill Co. as superintendent, will be connected with the Nazel organization.

In the notice relating to the consolidation of the KENT MACHINE Co. and the FALLS CLUTCH & MACHINERY Co., published in January MACHINERY, page 434, it was stated that S. B. Beck is general manager of the company. We have since been informed that this statement was incorrect, as A. B. Babbitt is secretary-general manager and has held this office for many years.

WESTINGHOUSE ELECTRIC & MFG. Co., East Pittsburg, Pa., announces that from the beginning of this year the prime mover sales activities of the company will be conducted by a new sales organization to be located at the South Philadelphia works. Howell Van Blarcom, formerly assistant to the manager of the power department at the South Philadelphia works, will be manager of the prime mover sales department.

ROTARY MFG. Co., manufacturer of heating appliances, will soon move into its new plant, 5718 Long Beach Ave., Los Angeles, Calif., which was especially designed for the company's requirements by Hamm & Grant, Inc., architects and engineers. The building is a one-story structure, 80 by 90 feet, and is made of brick and structural steel with a sawtooth roof. It is so designed that it may be conveniently enlarged to give a total floor space of approximately 14,000 square feet.

M. A. COOLIDGE has acquired all the real estate and personal property formerly belonging to the SPRINGFIELD AUTOMATIC SCREW MACHINE CORPORATION of Fitchburg, Mass. The property has been in the hands of trustees for about four years. The new concern will be known as the FITCHBURG AUTOMATIC MACHINE Co. B. J. Macker, who was connected with the former company, will be in charge. It is planned to carry on the business of manufacturing automatic screw machines that Mr. Coolidge formerly established, as well as to continue to furnish present users of machines with supplies and equipment.

STANDARD STEEL SPECIALTY Co., Beaver Falls, Pa., has taken over that portion of the business of the Union Drawn Steel Co., owner of the Standard Gauge Steel Co., devoted to the manufacture of machine and Woodruff keys, machine racks, taper pins, and other machined steel shapes. Plans are being made for the erection of a new plant in the early Spring. The officers are as follows: President and treasurer, E. J. Wagner, formerly secretary and general manager of the Standard Gauge Steel Co.; vice-president, Alex Gilliland; secretary and general sales manager, J. B. Jamison, formerly district sales manager for the Union Drawn Steel Co.

COMING EVENTS

JANUARY 30-FEBRUARY 6—National Automobile Show, to be held at the Coliseum, Chicago, Ill.

MARCH 2-5—Exhibit of road-building, road maintaining, and contractors' machinery, and road materials, to be held at the Coliseum, Wichita, Kan. F. G. Wieland, general manager, Exposition Building, corner Water and William Sts., Wichita, Kan.

MARCH 3-5—Annual convention of the American Management Association at the Hotel Astor, New York City. Secretary's address, 20 Vesey St., New York City.

MARCH 17-23—First national heating and ventilating exposition, including plumbing, refrigeration and illumination, at the New Madison Square Garden, Eighth Ave. and 49th St., New York City. Executive offices of the exposition, Suite 334, Hotel McAlpin, New York.

APRIL 6-8—Third annual convention and exposition of the American Oil Burner Association in Detroit, Mich. Headquarters, Book-Cadillac Hotel. Executive secretary, Leod D. Becker, 350 Madison Ave., New York City.

APRIL 28-30—Thirteenth annual convention of the National Foreign Trade Council in Charlestown, S. C. Secretary, O. K. Davis, India House, Hanover Square, New York City.

MAY 13-15—Annual meeting of the American Gear Manufacturers' Association in Detroit, Mich. Headquarters, Book-Cadillac Hotel; secretary, T. W. Owen, 2443 Prospect St., Cleveland, Ohio.

JUNE 19-26—Convention and exhibit of the Mechanical Division, American Railway Association, Young Million Dollar Pier, Atlantic City, N. J. Secretary of the Mechanical Division: V. R. Hawthorne, 431 S. Dearborn St., Chicago, Ill. Secretary-treasurer of the exhibit: J. D. Conway, 1841 Oliver Bldg., Pittsburg, Pa.

JUNE 21-25—Twenty-ninth annual meeting of the American Society for Testing Materials at the Chalfonte-Hadden Hall Hotel, Atlantic City, N. J. Secretary's address, 1315 Spruce St., Philadelphia, Pa.

SEPTEMBER 20-24—Eighth annual convention and exposition of the American Society for Steel Treating to be held at the Municipal Pier, Chicago, Ill. W. H. Eisenman, secretary, 4600 Prospect Ave., Cleveland, Ohio.

SEPTEMBER 27-OCTOBER 2—Annual convention of the American Foundrymen's Association and second international foundry congress in Detroit, Mich. In conjunction with these conventions there will be held an international exposition of foundry and machine shop equipment and supplies. C. E. Hoyt, secretary-treasurer, 140 S. Dearborn St., Chicago, Ill.

SOCIETIES, SCHOOLS AND COLLEGES

POLYTECHNIC INSTITUTE OF BROOKLYN, 99 Livingston St., Brooklyn, N. Y. Pamphlet outlining the points of interest about the institute for students of engineering and chemistry.

SCHOOL OF MINES AND METALLURGY OF THE UNIVERSITY OF MISSOURI, Rolla, Mo. Technical bulletin containing a bibliography on zinc retorts and condensers. Bulletin containing an article entitled "Engineering and Research," by Milo S. Ketchum.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, 33 W. 39th St., New York City. Series of pamphlets, containing the results of an investigation of engineering education conducted under a grant by the Carnegie Corporation. The pamphlets cover study of engineering students at the time of entrance to college; study of admissions and eliminations of engineering students; study of engineering graduates and former students; study of engineering teaching personnel; preliminary report on costs of engineering education. The data presented in these reports has been supplied by the cooperative committees of the faculties.

CALENDARS

CALENDAR. Moline Tool Co., Moline, Ill. Calendar for 1926.

CALENDAR. Keuffel & Esser Co., Hoboken, N. J. Vest pocket calendar for 1926, printed on a celluloid card.

CALENDAR. Barney Machinery Co., Union Trust Building, Pittsburg, Pa., formerly the Laughlin-Barney Machinery Co., is distributing to the trade a calendar for 1926.

CALENDAR. Lockwood, Greene & Co., Inc., 24 Federal St., Boston, Mass. Calendar for 1926, illustrating on each sheet a typical industrial or commercial building erected by this company.

CALENDAR. General Electric Co., Schenectady, N. Y. Calendar for 1926, containing three months on each sheet and twelve beautiful illustrations, in three colors, of the application of electricity in different fields.

CALENDAR. Carnegie Steel Co., Pittsburg, Pa., is distributing what is known as a "safety calendar," the object being to broadcast the idea of safety and to instill into the youth of the land the lessons of carefulness. On each sheet of the calendar is a safety poster made by boys and girls in public and parochial schools between the years of eleven and eighteen years; the posters reproduced were selected from over 9000 submitted in a contest for which prizes were awarded by the Carnegie Steel Co.

NEW BOOKS AND PAMPHLETS

A CENTURY OF PROGRESS. 755 pages, 5¼ by 8 inches. Published by the Delaware & Hudson Co., 32 Nassau St., New York City.

Book containing the history of the Delaware & Hudson Co. from its inception in 1823 up to and including 1923.

A STATISTICAL STUDY OF CONDITIONS AFFECTING THE DISTANCE RANGE OF RADIO TELEPHONE BROADCASTING STATIONS. By C. M. Jansky, Jr. 10 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper No. 297 of the Bureau of Standards. Price, 5 cents.

BOTHERING BUSINESS. By H. A. Toulmin, Jr. 57 pages, 4¾ by 7 inches. Published by the B. C. Forbes Publishing Co., Inc., 120 Fifth Ave., New York City.

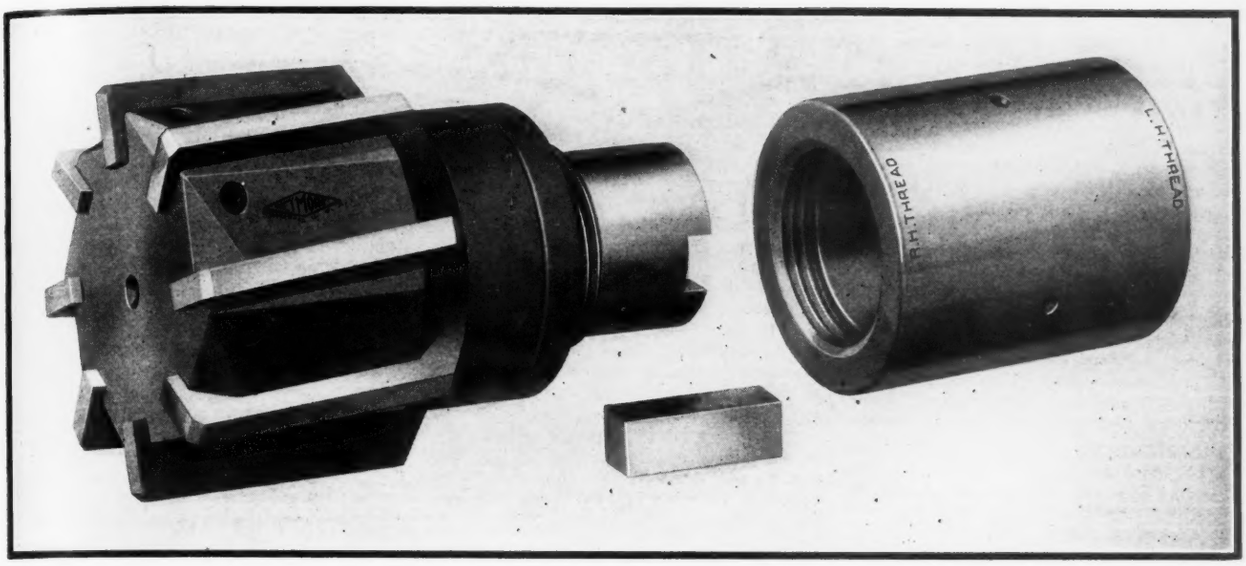
This little book which discusses the activities of the Federal Trade Commission, comprises a criticism of the commission as it now functions, and presents suggestions for changes that should be made in the method of procedure.

BUDGETING TO THE BUSINESS CYCLE. By Joseph H. Barber. 115 pages, 5 by 7 inches. Published by the Ronald Press Co., 15 E. 26th St., New York City. Price, $1.25.

This is one of a series of books comprising the Ronograph Library, the purpose of which is to provide a comprehensive source of information on the many varied problems arising from day to day in the conduct of business. The present work discusses the problem of budgeting, and gives in detail, for the guidance of others, the complete experience and methods of a large manufacturing concern in preparing its budget with a view to suiting it to the fluctuations of the business cycle. The book gives concrete examples with tables and charts based upon actual data of the business.

MECHANICAL WORLD YEAR BOOK (1926) 348 pages, 4 by 6 inches. Published by Emmott & Co., Ltd., 65 King St., Manchester, England. Price, 1/6.

This is the thirty-ninth edition of this well-known little year book of mechanical engineering. The new features of the present edition include sections on the Uniflow engine, fuel economizers, forced and shrinkage fits, and chains and ropes. Another important new section "Notes on Grinding" gives many tables and data relating to grinding allowances, information relating to various abrasives, etc. Some of the other sections have been rewritten and others revised where necessary to bring them up to date. As in previous editions, a classified buyer's directory in English, French, and Spanish is included.



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1" to 2 15/16"...6 blades
3" to 4 1/2".....8 blades

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THIS Wetmore "Bull-Dog" Reamer combines all the advantages of both solid and adjustable reamers. Key drive relieves strain on coupling nut, or reamer can be furnished with arbor integral. Large adjustment provides for wear and regrinding, so that this reamer with its original blades actually outlasts several solid, non-adjustable reamers. The 1/8" projection of the blades over the end of the reamer body allows the chips to fall off ahead of the reamer and prevents chips from clogging up along cutting edge of blades.

Wetmore Expanding Reamers are being specified in many of the largest shops because they *cut production costs,* (1) by doing faster, more accurate work; (2) by their longer life. Here are a few Wetmore features that appeal to production men:

The method of holding the blades in the Wetmore Heavy-duty Reamer eliminates unnecessary extra parts. This saves time and simplifies the replacement and adjustment of blades.

All Wetmore blades are scientifically ground for working various metals — steel, cast iron, bronze, etc. Best high-speed steel, ground to thickness, length and on seat. Tested for hardness and toughness. In ordering, give type and size of reamer and whether reamer is to be used on steel, cast iron or bronze.

Adjustments to the thousandth of an inch can be made in less than a minute. In fact, the Wetmore is the quickest and easiest adjusting reamer made.

Cone expansion nut keeps blades always parallel with axis.

Solid, alloy steel body, heat treated, guaranteed against breakage.

Left Hand Angle Cutting Blades that prevent digging in, chattering and scoring of the reamer while backing out. Shearing effect of blades increases life of cutting edge.

No grinding arbor required for regrinding. Wetmore Reamers can be reground on their original centers.

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WETMORE EXPANDING REAMERS
"THE BETTER REAMER"

HUTTE ENGINEERING HANDBOOK, Vol. I. 1080 pages, 4¾ by 7¼ inches. Published by Wilhelm Ernst & Son, Berlin, Germany.

This is the twenty-fifth edition of the well-known German engineering handbook known as "Hutte," the first edition of which was published in 1857. This engineering reference work, for as such it must be designated, is now published in four volumes, covering the entire engineering field. The first volume deals with the theoretical foundation of engineering, including mathematics, mechanics, physics, theory of heat, strength of materials, properties of materials, and measurements. The second volume deals with machine elements, power plant machinery, machine tools, and electricity. The third volume deals mainly with civil engineering matters, and the fourth, with transportation, mining, agricultural engineering, and specific industries.

PUNCHES, DIES, AND GAGES. By Albert A. Dowd and Frank W. Curtis. 341 pages, 6 by 9 inches. Published by the McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City. Price, $3.50.

This book, which is the third volume in a tool engineering series, treats of dies, both forging and punch press, the design of gages for interchangeable manufacture, the limit system, modern drafting-room practice, elementary pattern work, feeds and speeds, and cutting lubricants. Particular attention is given to die design. The text is divided into fourteen chapters headed as follows: Design of Drop-forging Dies; Design of Cutting and Shaping Dies; Progressive Blanking Dies; Design of Piercing Dies; Design of Drawing Dies; Compound Dies, their Principles and Advantages; Design of Gages; Design of Reference and Work Gages; Inspection Gages; Gaging Screw Threads; Cutting Lubricants and their Application; Speeds and Feeds of Machine Tools; Pattern Work and its Relation to the Designer; and Organization of the Tool Drafting Department.

NEW CATALOGUES AND CIRCULARS

SPEED REDUCERS. Foote Bros. Gear & Machine Co., 232-242 N. Curtis St., Chicago, Ill. Circular descriptive of IXL continuous-tooth herringbone speed reducers.

BUCKETS. Joseph F. Kiesler Co., Chicago, Ill. Circular illustrating and describing Kiesler clam shell buckets, which are adapted for dredging, excavating, and all general purposes.

BALL BEARINGS. New Departure Mfg. Co., Bristol, Conn. Circular entitled "Proved," illustrating some of the seventy-six major inspections of New Departure ball bearings.

MILLING CUTTERS. Reed-Prentice Co., Worcester, Mass. Bulletin containing dimensions and price list of milling cutters and collets for Becker Nos. 1, 2, and 2A vertical milling machines.

FLOW METERS. General Electric Co., Schenectady, N. Y. Pamphlet GEA-133, illustrating various types of G-E electrically operated flow meters for measuring steam, water, oil, gas, etc.

HYDRAULIC MACHINES. Oilgear Co., 657 Park St., Milwaukee, Wis. Bulletin 40, illustrating the application of Oilgear high-speed hydraulic broaching machines, presses, lathes, and boring mills.

RHEOSTATS. Allen-Bradley Co., Milwaukee, Wis. Bulletin 410, illustrating and describing the important features of types E-2100 and E-2200 controlling rheostats for general industrial application.

FIRE EXTINGUISHER. Bastian-Blessing Co., 240 E. Ontario St., Chicago, Ill. Circular describing the "Rego" fire stopper, which will put out all kinds of fires instantly, including gasoline, alcohol, and oil fires.

TURBINES. General Electric Co., Schenectady, N. Y. Folder GEA-197, descriptive of type D-54 General Electric steam turbines for driving centrifugal pumps, blowers, and other classes of mechanical drive.

DRILLS, SPOT FACERS, AND COUNTERBORES. Gairing Tool Co., Inc., Detroit, Mich. Circular illustrating typical examples of the Gairing line of tools for spot-facing, counterboring, and core-drilling operations.

GRINDING MACHINES. Heald Machine Co., 16 New Bond Street, Worcester, Mass. Pamphlet entitled "The First Ledger," published in commemoration of the one-hundredth anniversary of the founding of the company.

MATERIAL HANDLING EQUIPMENT. Westinghouse Electric & Mfg. Co., East Pittsburg. Pa. Circular 7378, treating of the subject of materials handling, with reference especially to the use of electrically driven machinery.

ELECTRICAL EQUIPMENT. Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Publication reviewing the engineering achievements of the company for the year 1925, prepared by H W. Cope, assistant director of engineering.

TURRET LATHES. Foster Machine Co., Elkhart, Ind. Circular and photograph illustrating and describing machine and tooling equipment by which 77 parts a day were produced instead of 27, at a saving of $27.70 per day.

VENTILATING EQUIPMENT. American Blower Co., Detroit, Mich. Bulletin 4, treating of the proper ventilation of service stations and garages, and outlining the advantages of "Ventura" fans and "Sirocco" blowers in this field.

WASTE METERS. Uehling Instrument Co., 473 Getty Ave., Paterson, N. J. Circular illustrating the Uehling waste meter, which gives a record of furnace conditions and enables an engineer to accurately account for the heat wasted.

METAL PARTS WASHING MACHINE. Colt's Patent Firearms Mfg. Co., Hartford, Conn. Bulletin describing the features of construction of the Colt "Autosan" metal parts washing machine, and illustrating the different models.

ENTROPY CHART. DeLaval Steam Turbine Co., Trenton, N. J. An entropy chart for the use of engineers who have occasion to calculate quantities connected with the expansion of steam. Copies will be sent to those interested, upon request.

INTERNAL MICROMETERS. John Bath & Co., Inc., Worcester, Mass. Circular entitled "The Truth about Internal Measurements," descriptive of the advantages of Bath internal micrometers, which read directly in ten-thousandths inch.

SAWS. Huther Bros. Saw Mfg. Co., Inc., Rochester, N. Y. Catalogue 46, covering the line of circular saws, saw fitting machinery, and special grooving saws made by this concern. Dimensions and price lists are given for the different sizes.

WORM-GEARING. David Brown & Sons, Ltd., Park Works, Lockwood, Huddersfield, England. A treatise containing technical information on the design and manufacture of worm-gearing, with special reference to automobile transmissions.

WIRE FORMING MACHINES. Baird Machine Co., Bridgeport, Conn. Circular illustrating Baird automatic machines, including a four-slide wire and ribbon former, two-slide power press, single-action open-back press, and ball burnishing machine.

ROLLER BEARINGS. Roller Bearing Co. of America, 141 Frelinghuysen Ave., Newark, N. J. Catalogue 2, containing tables of dimensions and list prices for "Little Giant" roller bearings for automobiles, tractors, and industrial applications.

MACHINERY, TOOLS, AND SUPPLIES. Louis E. Emerman & Co., 1761 Elston Ave., Chicago, Ill. Emerman Red Book No. 25, containing a list of machinery, tools, and supplies that this company now has in stock, together with brief descriptions and prices.

KEYWAY MILLING MACHINES. Ingersoll Milling Machine Co., Rockford, Ill. Circular illustrating and describing the Ingersoll open-side keywaying machine, which is suitable for use in shops that have to cut keyways of different sizes in a wide range of shafts.

HOBBING MACHINES. Gould & Eberhardt, Newark, N. J. Bulletin 148, descriptive of the development, principles of design, and features of the G & E 16 HS manufacturing hobbing machine, which is designed for both roughing and finishing either spur or helical gears.

SCREW MACHINE PRODUCT AND CHIP SEPARATOR. McKenzie Engineering Co., New Rochelle, N. Y. Circular illustrating and describing a machine recently placed on the market for separating finished screw machine parts from the chips after the oil has been extracted.

ELECTRIC FITTINGS. Crouse-Hinds Co., Syracuse, N. Y. Circular illustrating condulets for fuse cutouts. The two types suited for this service are known as the Y Series and the YY Series, both of which are illustrated. Bulletin 2075, containing data on a new type F service entrance condulet.

HOMO ELECTRIC DRAWING METHOD. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. Circular entitled "Controlling the Changes in the Physical Properties of Steel during the Drawing of Production Quantities," briefly outlining the principles of the "Homo" electric drawing method and equipment.

BEARING METAL. Sumet Corporation, 1543 Fillmore Ave., Buffalo, N. Y. Booklet descriptive of Sumet bronze bearing metal. The physical characteristics of the different grades of this metal are listed, as well as the applications for which each grade is particularly suited. The metal is supplied in the form of cored and solid bars.

VERTICAL MILLING ATTACHMENT. Kearney & Trecker Corporation, Milwaukee, Wis. Circular illustrating and describing the Kearney & Trecker new two-spindle vertical milling attachment, designed to handle work where a true relation between two milled surfaces is required, so that it is necessary to mill both at the same time.

GEAR SHAPERS. Fellows Gear Shaper Co., Springfield, Vt. Booklet entitled "Put Money in Your Purse," which illustrates and explains how savings have been made in gear-cutting by changing the methods of handling the work and in some cases by modifying its design. The examples shown have been chosen from a variety of industries to illustrate the wide adaptability of the high-speed gear shaper.

SPEED REDUCERS. DeLaval Steam Turbine Co., Trenton, N. J. Booklet illustrating and describing the DeLaval "Superior" line of speed reducers for use with standard or high-speed motors driving slow or moderate-speed machinery, including worm reduction gears of the horizontal and vertical shaft and double-reduction types, helical gears for low ratio, and double helical gears for high-power service.

SCREW MACHINES. Brown & Sharpe Mfg. Co., Providence, R. I. Catalogue 24G, covering the Brown & Sharpe line of screw machines of the plain, wire feed, and automatic types, as well as attachments and tools. The general features of design of these machines are outlined, and a detailed description of the construction is given. The complete descriptions are followed by specifications and illustrations of the different sizes and types.

DIE-HEADS. Eastern Machine Screw Corporation, 23-43 Barclay St., New Haven, Conn. Catalogue on H & G self-opening die-heads, describing the construction and application of the three styles of these die-heads and giving tables of dimensions and capacities for the different sizes. The appendix of this catalogue contains extracts from the report of the Screw Thread Commission appointed by Congress, which should be of value to all users or producers of threaded parts.

HIGH-SPEED DRILLS. Morse Twist Drill & Machine Co., New Bedford, Mass. Circular of Morse high-speed forged and high-speed milled drills. The forged type of drill illustrated has just been brought out by the company to meet the demand for drills of this type, and the company is prepared to furnish either the forged or the milled type of drill. The last page of the circular shows comparative sizes of the forged and milled types. Copies of the circular can be obtained by those interested, upon request.